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The economic burden of chronic back pain in the United States: a societal perspective

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The economic burden of chronic back pain in the United States: a societal perspective

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Dedication

This work is dedicated Ma, Pa, Ruchi, and Bhriguji, without whose support and encouragement I would never have made it this far.

The economic burden of chronic back pain in the United States: a societal perspective

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Abstract

Back pain is the 6th most costly condition in the United States and is responsible for the most workdays lost. Approximately 33 million American adults suffered from back and neck problems in 2005. The societal cost of chronic back pain (CBP) has not been calculated from a US perspective.

Longitudinal data files from Panels 12, 13, and 14 of the Medical Expenditure Panel Survey (MEPS) were used to estimate excess direct (ambulatory visits, inpatient admissions, emergency room visits, and prescription medication) costs and indirect (lost productivity) costs for persons 18 years and older reporting CBP compared to those not reporting back pain. Persons were included in the CBP group if they reported back pain (*ICD-9-CM* codes 720, 721, 722, 723, 724, 737, 805, 806, 839, 846, 847) in at least 3 consecutive interview rounds. The complex sampling design of MEPS was taken into account to get accurate national estimates. All costs were adjusted to 2011 using Consumer Price Indices. All mean costs were computed using age-stratified regression models, after adjusting for demographic and clinical covariates. Utilization of provider-based complementary and alternative medicine (CAM) among CBP patients was studied, and differences in costs between CAM users and non-users examined.

Based on this analysis, the prevalence of CBP in the adult US population was estimated to be 3.76%. Total all-cause costs for CBP patients were estimated to be \$187 billion over 2 years (direct costs = \$176 billion, indirect cost = \$11 billion). Overall estimates of excess costs of CBP over 2 years per person for direct medical costs were \$37,129 (\$25,273 vs. \$48,984; $p<0.001$). This breaks down to \$11,711 (\$14,929 vs. \$3,219; $p<0.001$) for ambulatory visits; \$3,560 (\$6,514 vs. \$2,914; $p<0.001$) for inpatient admissions; \$300 (\$690 vs. \$390; $p<0.001$) for emergency department visits; and \$19,849 (\$23,873 vs. \$4,024; $p<0.001$) for prescription medications. Excess indirect costs for CBP patients were \$1,668 (\$2,329 vs. \$661; $p<0.001$). Thirty-seven percent of CBP patients reported at least one CAM visit. There was no significant difference in overall costs between CAM users and non-users.

The high cost of chronic back pain in the US population has potential implications for prioritizing policy, and in attempting to improve care and outcomes for these patients.

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Chapter 1: Introduction and Literature Review

The 2010 Patient Protection and Affordable Care Act identified pain as a public health problem and commissioned the Department of Health and Human Services to involve the Institute of Medicine (IOM) in its examination of this issue.[1] The IOM emphasized the need for research on costs of pain and the financing of pain research, along with better research on treatment delivery, epidemiology, and care.

Originally, this research project was constructed to assess the burden of chronic **lower** back pain, but due to small sample sizes, it was expanded to include chronic back and neck pain. According to a study published in 2006, the prevalence of lower back pain that lasted a whole day or more (pain that was specifically not fleeting or minor) in the past 3 months was 26.4%; and approximately 2.3% of all physician visits were attributable to low back pain.[2] Back pain is the 6th most costly condition in the United States and is responsible for the most workdays lost.[3] Approximately 33 million American adults suffered from back and neck problems in 2005.[4]

While it is acknowledged that chronic back pain is a costly condition,[5] it is imperative to accurately estimate the costs associated with this condition before attempting to implement cost-saving measures or conducting pharmacoeconomic evaluations of interventions.

PREVALENCE OF CHRONIC BACK PAIN

A review of cross-sectional studies conducted in the United States estimated the annual incidence of back pain in US adults at 10-15% and point prevalence at 15-30%.[6] The study found that most back pain patients (90% or more) recover within 3 months; resource utilization (healthcare services as well as cost) is high for the remaining patients who recover more slowly. The productivity loss for back pain patients is also very high due to major disability. However, the estimates reported in the review are outdated (the review is based on data collected between 1985 and 1995).

Prevalence of chronic back pain in the United States

It is difficult to estimate the true prevalence of this disabling and costly problem because researchers operationalize the definition of chronic back pain (CBP) in a variety of ways. Some studies define it solely on duration (3 months – 6 months or more), some define it on duration and impaired functionality, and some define it on duration of the problem as well as the number of episodes (e.g., >25) within a specified period. Even if studies using the same definition are compared, sample size, generalizability issues, recall bias, and selection biases, all make it a less than ideal comparison. Thus, when evaluating prevalence estimates, it becomes important to first review the exact definition of CBP applied by the authors to identify cases.

Martin et al. used 1997 to 2005 Medical Expenditure Panel Survey (MEPS) files and found an increase in prevalence of CBP from 1997 to 2005, with approximately 33 million (15%) American adults reporting long-standing back pain in 2005.[4] The CBP group were more likely to be older, unemployed, publicly insured, white, and female. Smith and colleagues also used MEPS to analyze prevalence trends and costs of CBP in the US population.[7] The prevalence trends and estimates will be discussed here while costs will be discussed in the relevant section below. Smith et al. used MEPS Longitudinal Files spanning 2000 to 2007 and analyzed data for community-dwelling adults (18 years or older at entry into MEPS). Individuals were identified as having back pain if they had been assigned *Clinical Classification Category* (CCC) code '205' and/or *International Classification of Diseases, Ninth Revision* (ICD-9) codes '846' or '847'. Of the 12,104 individuals (across all years) identified as reporting back pain in at least 1 interview round (out of a maximum of 5), approximately 3,842 individuals reported back pain in at least 3 rounds, (did not have to be consecutive) and were classified as having *chronic* back pain. After applying weights provided in the MEPS datasets, period prevalence estimates were shown to increase from 4.0% (weighted estimate = 7.8 million) in 2000-2001 to 6.1% (weighted estimate = 12.8 million) in 2006-2007.

Other researchers focus on estimating the prevalence of specific subsets of CBP. Strine et al. used the 2002 National Health Interview Survey (NHIS) data files to obtain estimates of prevalence of neck and low back pain in US adults 18 years or older.[8] In 2002, the NHIS included interviews with 31,044 adults.[9] Low back pain was defined in the study as an affirmative response to the question: "The following questions are about pain you may have experienced in the past 3 months. Please refer to pain that lasted a whole day or more. Do not report aches and pain that are fleeting or minor. During the past 3 months did you have low back pain?" The presence of neck pain was assessed with a similar question. The researchers found that 26.3% (weighted estimate = 53 million) adults (age ≥18 years) reported having low back pain in the last three months. Approximately 17.0% (weighted estimate = 34 million) adults reported having only low back pain, while 4.4% (weighted estimate = 19 million) reported having both neck and low back pain. All three conditions were more prevalent in women and older people. In addition, they also found that persons with low back pain only were more likely (OR =

1.8; 95% CI = 1.5-2.3) to have a potential serious mental illness (e.g., depression, anxiety disorders), after controlling for sociodemographic factors. Some limitations of this study included lack of information on severity and duration of the reported pain. Since pain in all areas of the back were not assessed in this study, the back pain prevalence estimate obtained cannot be thought to accurately quantify the epidemiologic burden of specifically CBP.

Johannes et al. conducted an internet-based survey to assess the prevalence and predictors of chronic pain in a nationally representative sample of US adults (≥18 years of age).[10] The researchers used a database maintained by Knowledge Networks, Inc. that was designed to be nationally representative on age, race, Hispanic ethnicity, income, education, employment, and geographic region. The study was conducted between December 2008 and February 2009. Persons were included in the study if they gave informed consent and reported having chronic, recurrent, or long lasting pain for at least 6 months. Participants were asked to characterize the pain on the basis of location, severity, and frequency. The weighted point prevalence of primary chronic pain in the back was found to be 8.1% (95% CI = 7.5-8.7). The prevalence did not differ by gender but increased with increasing age.

Using an internet-based survey brings about a selection bias in the sample; the validity of the claim that the sample is nationally representative can be called into question. An analysis of the 1999-2002 National Health and Nutrition Examination Survey (NHANES) data files found CBP prevalence in US adults to be 10.1% (95% CI = 9.0-11.2).[11] The difference in the results could be due to a difference in the time-frame of the two surveys, or because the internet-based survey underestimates the prevalence of CBP due to its sampling strategy and inherent bias.

In Italian adults aged 65 years or older, CBP prevalence was estimated at 31.7%.[12] A study completed in the UK analyzed questionnaire responses from 1,455 adults in 1994 and 1997.[13] Prevalence of CBP was estimated at 6.3% in 1994 and 11.1% in 1997. Poor generalizability of these estimates, even within the same country, is a limitation. Point prevalence of CBP in France was 8% in adults aged 30 to 64 years.[14]

Conclusion

Studies report varied estimates of prevalence of CBP in the US. Sample size, study population, study setting, CBP definition, and other potential limitations influence these estimates. Similar to the limitations associated with US estimates, differences in CBP definition, study population, and methodology, in addition to outdated estimates, make it difficult to get a clear picture of CBP prevalence in the rest of the Western world.

ECONOMIC BURDEN OF CHRONIC BACK PAIN

Direct costs associated with chronic back pain

Smith et al. analyzed costs (in 2010 US$) attributed to ambulatory visits for CBP among community-dwelling US adults.[7] The study design has been briefly described in the "Prevalence of chronic back pain" section. The researchers found that of the individuals included in the CBP group, 78% received only ambulatory care. Total expenditure on ambulatory visits due to CBP increased from $15.6 billion in 2000-2001 to $35.7 billion in 2006-2007. Mean expenditure per adult in the CBP group increased from $2,235 in 2000-2001 to $3,152 in 2006-2007. Mean expenditure for individuals in the CBP group was much higher than for individuals reporting back pain in less than 3 of the 5 interview rounds ($3,152 vs. $903 in 2006-2007). Martin and colleagues reported all-cause direct costs in back pain patients in the US to be $85.9 billion in 2005.[4] There was a 65% increase in total costs from 1997 to 2005. Total cost for inpatient admissions, ambulatory visits, emergency room visits, and prescription medications in 2005 were $23.7 billion, $30.8 billion, $2.6 billion, and $19.8 billion, respectively. Age- and sex-adjusted mean expenditures were substantially higher in back pain patients ($6,096 in back pain group vs. $3,516 in Control group).

Gore et al.[15] evaluated direct medical costs in chronic lower back pain (subset of chronic back pain identified using ICD-9 diagnosis codes) patients for 2008 using the IMS LifeLink™ US Claims Database. The researchers estimated mean annual direct medical costs at US$ 8,386±US$ 17,507 with outpatient visits accounting for the highest proportion of costs for CBP patients (US$ 4,922±US$ 9,265 per patient per year).

Depont et al.[16] interviewed patients, identified by their general practitioners as having chronic lower back pain, about direct medical as well as non-medical costs between October 2001 and December 2002. Total direct costs were estimated at €569,619 (non-medical = €104,013 and medical = €465,606; €1 = US$1.46 as of December 31, 2007) for 6 months. Mean direct costs (per patient annually) were estimated at €1,430. However, the study had various limitations and assumptions that may have resulted in misestimating costs. Reported costs were actually charges (i.e., billed amounts) and included the reimbursed as well as non-reimbursed portion of healthcare expenditure. The study was conducted in 2002 but unit cost estimates from 2007 were used, which might have resulted in costs being overestimated. A major assumption made was that costs would remain constant in the second half of the year and the 6-month cost estimates obtained were doubled to obtain annual estimates. A self-selection bias is also possible in this study because physicians who responded to an invitation to participate in the study identified patients who would be included in the analysis. The study was limited in its scope by the primary care setting and few cost categories (as compared to other studies).

Sharma and colleagues used a questionnaire-based study design to evaluate office-based costs (X-rays and prescribed medicines) for patients with back pain identified by chiropractors and physicians.[17] For patients identified by chiropractors, mean office-based costs at 12-month follow-up were US$209 (SD = US$283). Patients enrolled by physicians had lower mean office-based costs at 12-month follow-up [US$122 (SD = US$128)].

Societal costs associated with chronic back pain

We searched the published, biomedical English-language literature for studies reporting societal costs (direct and indirect costs) for chronic back and neck pain. However, cost-of-illness studies for this problem have not been conducted in the US or internationally. We found few studies reporting estimates of societal costs, specifically, chronic **lower** back pain. The studies were carried out in four different countries (USA, Germany, Sweden, and The Netherlands).[18-21] Indirect costs accounted for 54-85% of total societal costs. All four studies used different definitions for chronicity as well as different cost categories; thus, comparison of costs might be misleading.

Ivanova et al. conducted a study using data from 2004 to 2006 from an American private insurance claims database (n = 35,295) and studied health services costs, prescription medication costs, absenteeism costs, and employer payments for disability days.[18] The authors found that 16.7% of patients with low back pain developed long-standing, chronic pain. In low back pain patients who did not undergo surgery, mean annual direct costs were US$ 8,513 (SD = US$ 18,921) vs. US$ 6,298 (SD = US$ 17,139) more than patients without back pain. Annual mean direct costs in low back pain patients who underwent surgery were US$ 38,868 (SD = US$ 47,755) vs. US$ 29,054 (SD = US$ 34,783) more than patients without back pain. Compared to control group enrollees, low back pain patients had significantly greater disability days (7.1 days vs. 2.7 days), and medically related absenteeism days (8.4 days vs. 2.2 days) ($p<0.001$ for both). Annual mean indirect costs were US$ 2,606 (SD = US$ 4,876) per employee with low back pain per year vs. US$ 750 (US$ 2,525) for controls (n = 91,194 in each group). All costs in the study were reported in 2006 US$.

A group of researchers in Germany conducted a secondary analysis of patient interview data from a randomized controlled trial to determine societal costs of low back pain.[19] Patients with back pain (n = 451) reported mean total societal costs as € 1,790 (95%CI: € 1,470 – € 2,202), mean total indirect costs (52% of total) as € 936 (95%CI: € 708 – € 1,236), and mean total direct costs as € 854 (95%CI: € 714 – € 1,045), in 2004 € (€1 = US$1.35 as of December 31, 2004). Therapeutic procedure costs accounted for the largest proportion of direct costs (30%).

Similar cost-of-illness studies (patient interviews) were conducted in 2002 in Sweden and The Netherlands.[20,21] However, both studies had smaller sample sizes (n = 302 for the Swedish study, n = 135 for the Dutch study) than the German study. In Sweden, indirect costs accounted for 85% of total costs with annual mean direct medical costs estimated at US$ 2,911 (€ 3,090; author reported values in both currencies) (95%CI: US$ 2,081 – US$ 3,742), and annual mean indirect costs estimated at US$ 16,561 (€ 17,600) (95%CI: US$ 14,601 – US$ 18,522). Patients with more severe disease ($p<0.001$), and longer disease duration ($p = 0.046$) incurred higher costs. The Dutch study estimated mean direct medical costs at € 1,104 (median = € 594), mean direct non-medical costs at € 4,491 (median = € 2,502), and mean indirect costs at € 2,939 (median = € 0). However, the patient recruitment process for the Dutch study is unclear. Additionally, a more conservative definition of low back pain (pain for >6 months duration) might have resulted in an underestimation of costs.

A study of low back patients in Switzerland reported direct costs of € 2.6 billion in 2005 (€1 = US$1.18 as of December 31, 2005) (6.1% of total healthcare expenditure), while productivity losses were reported to be € 4.1 billion using the Human Capital approach.[22] One of the strengths of this study was that it also estimated productivity loss while at work but not functioning at full capacity (presenteeism) and found that it had the largest contribution to costs of back pain patients. However, these estimates were an extrapolation of reported losses in a 4-week period before questionnaire administration, making the estimates unreliable for our purposes.

UTILIZATION OF PROVIDER-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE (CAM) FOR CHRONIC BACK PAIN

Chiropractic care

According to latest figures available from the Bureau of Labor Statistics, there are about 52,600 practicing chiropractors in the United States.[23] Chiropractic care is now reimbursed by public as well as private insurance, and subjected to regulations in all 50 states.[24] Utilization of chiropractic care has been on the rise in the United States since the late 1990's.[25] Analyzing the Medical Expenditure Panel Survey (MEPS) files, Davis et al. reported that the number of Americans older than 18 years who visited a chiropractor at least once rose from 7.5 million in 1997 to 12.6 million in 2006 (an increase of 68%).[26] Another study indicated that approximately 12 million Americans (5.2%; 95% CI: 4.7-5.6%) older than 18 years visited a chiropractor at least once during 2008.[27] The total number of visits to chiropractors rose from 64 million in 1997 to 109 million in 2006 (an increase of 70%); however, the annual mean number of visits per patient remained stable over the study period – 8.5 visits per year. Various reports indicate that the majority of chiropractic service users are white, female, had attended college, were privately insured, and were between 45-50 years of age.[26-28]

For back pain in general, expenditures for chiropractic care have been reported to be lower than for conventional medical care. Mean expenditure per chiropractic office visit in 2006 US$ was statistically significantly lower than mean expenditure per visit for office-based medical doctor visits ($57 vs. $177; $p < 0.01$).[26] A retrospective analysis of the Blue Cross Blue Shield of Tennessee's claims database showed that the risk-adjusted cost for a low back pain episode of care initiated with a chiropractor was 20% lower than care initiated with a medical physician [Mean (SE) = $532.54 (±$9.56) for chiropractor vs. \$661.10 (±\$29.16) for MD; $p = 0.01$].[29] Compared with back pain patients without coverage for chiropractic services, patients with coverage for chiropractic care have been shown to have fewer hospitalizations (9.3 vs. 15.6; $p < 0.001$), surgeries (3.3 vs. 4.8; $p < 0.001$), and imaging procedures (43.2 vs. 68.9; $p < 0.001$), as well as lower costs per episode (\$289 vs. \$399; $p < 0.001$).[28] Another study, a cost minimization analysis, reported lower median cost per patient suffering from low back pain using chiropractic care (\$417) compared to medical management (\$576).[30]

Acupuncture

Acupuncture is a therapeutic intervention that is part of "traditional Chinese medicine" and consists of inserting fine needles into or through the skin at specific sites on the human body.[31,32] It is based on the concept of harmony between the body and nature. Any disturbance in this harmony is thought to block the body's vital energy (known as qi – flows along 12 primary and 8 secondary meridians) and is expressed as tenderness on palpation. Insertion of acupuncture needles at certain points along the meridians is believed to reestablish the flow of qi and restore internal harmony. In recent years, acupuncture as a treatment option for CBP patients has gained endorsement from the American College of Physicians and the American Pain Society.[33,34]

Maryland was the first state to legalize acupuncture in the early 1970's.[35] Currently, acupuncture is regulated in 43 states and the District of Columbia.[36] As of 2010, there were approximately 18,000 licensed acupuncturists in the United States.[37] In 2007, three million American adults reported using acupuncture.[38] Between 1997 and 2007, there was a 3-fold increase in visits to acupuncturists in the United States.[39] Medicare and Medicaid do not cover acupuncture services but coverage from supplemental insurers is increasing steadily.[40]

On analysis of the 2007 National Health Interview Survey (NHIS) data, Zhang et al. found that mean out-of-pocket cost per acupuncture visit was $103.03 (95% CI: $78.44-$127.61), while the median cost was $48.30.[41] Zhang and colleagues also reported that approximately 44% of acupuncture users made 2 to 5 visits during 2007, and approximately 15% users made more than 10 visits. The typical acupuncture user was middle-aged, female, White, and college-educated. Acupuncture has been shown to decrease healthcare resource utilization (costs as well as physician visits) in CBP patients.[42]

Massage therapy

Only a few studies report on the use of massage therapy by American adults. Data from NHIS indicate a 67.2% increase in the use of massage therapy for any cause from 2002 to 2007.[43] Combined with exercise and education, massage therapy is effective for CBP patients.[44] However, benefits from massage for back pain (pain relief as well as functional improvement) lasts approximately 6 months; any difference in benefit between massage and usual care is not clinically meaningful at 1 year follow-up.[45] Costs and savings associated with massage therapy have not been studied extensively. Mean costs for patients undergoing massage for CBP were approximately 40% lower than patients utilizing acupuncture or usual care but the differences were not statistically significant.[46]

GAPS IN THE LITERATURE AND STUDY RATIONALE

A glaring gap in the literature is the lack of a national estimate of the economic burden of CBP in the United States. Cost-of-illness studies can be very useful to policy makers and researchers.[47] They help triage decisions about which diseases require focus urgently and provide information on the financial impact of the disease. Burden of illness estimates also help prioritize research and development efforts. Cost-of-illness studies also provide estimates and a framework for cost-effectiveness and cost-benefit analyses. From the evidence presented earlier, it is apparent there is paucity of cost-of-illness studies from a societal perspective carried out in the United States. Even though direct medical costs for CBP patients have been analyzed (the latest estimates being from 2007), indirect costs for CBP patients in the US were not reported. An up-to-date epidemiologic and economic estimate will help in understanding the burden of this disorder on the healthcare system and society, both in clinical and economic terms.

Computing a national estimate of the cost-of-illness of CBP from a societal perspective would include estimating direct medical as well as indirect costs of patients suffering from this condition and requires a prevalence-based analysis of data from a nationally representative survey like the Medical Expenditure Panel Survey (MEPS). MEPS is the only publicly available, nationally representative database that has all the required information for this kind of analysis and is available as a longitudinal panel dataset with a follow-up period of 2 years for each non-institutionalized civilian person included in the dataset.

For patients with back pain, provider-based complementary and alternative medicine (CAM) is an effective supplement to conventional medical care. Utilization might have an effect on clinical as well as economic outcomes. This study examined utilization of provider-based CAM for CBP as well as differences in direct medical and indirect costs between patients who utilize such modalities of treatment compared to those who do not.

The main objective of this study was to evaluate the societal economic burden for patients diagnosed with conditions known to cause CBP. This includes costs (out-of-pocket as well as by payers) for all medical and pharmacy services used by these patients as well as costs associated with lost productivity. We used the econometric approach, also known as the ‘incremental’ method, to assess the economic burden of CBP patients. In other words, a national estimate of excess costs of CBP patients compared to individuals without CBP was computed.

Chapter 2: Objectives, Hypotheses, and Methods

SPECIFIC OBJECTIVES

1. To report aggregate statistics/measures of demographic characteristics of individuals with CBP in the community-dwelling, adult population of the United States. These characteristics include age, gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities. Means and standard errors will be computed for continuous variables, and frequencies and percentages for categorical variables.
2. To estimate the prevalence of CBP in the community dwelling, adult population of the United States.
    a. To estimate national prevalence of CBP in community-dwelling US adults.
    b. To estimate the prevalence of CBP in the community dwelling, adult population of the US, stratified by age group (18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and ≥65 years).
    c. To estimate the prevalence of CBP in males and females in the community dwelling, adult population of the US, stratified by age group.
3. To estimate national mean excess direct medical costs of CBP per person stratified by age, after controlling for demographic and clinical factors, and using the incremental cost approach.
    a. To estimate national mean excess costs per person, stratified by age, for office-based and hospital outpatient department physician visits (ambulatory visits) between individuals with CBP and those without.

b. To estimate national mean excess costs per person, stratified by age, for hospital inpatient admissions between individuals with CBP and those without.
c. To estimate national mean excess costs per person, stratified by age, for emergency room visits between individuals with CBP and those without.
d. To estimate national mean excess costs per person, stratified by age, for prescription medications between individuals with CBP and those without.

4. To estimate national mean excess <u>indirect</u> costs (lost productivity based on the number of work-days the person lost due to illness or injury) of CBP per person stratified by age, after controlling for demographic and clinical factors, and using the incremental cost approach.
5. To compute an estimate of total national societal costs (direct medical + indirect) of CBP.
6. To estimate the proportion of CBP patients who have visited CAM providers at least once during the study period.
7. To estimate and compare national mean <u>direct</u> medical and <u>indirect</u> costs between CBP patients who use provider-based CAM services at least once during the study period and those who did not use such services, stratified by age.
    a. To estimate and compare national mean direct medical costs between CBP patients who use provider-based CAM services at least once during the study period and those who did not use such services, stratified by age.
    b. To estimate and compare national mean indirect cost between CBP patients who use provider-based CAM services at least once during the study period and those who did not use such services, stratified by age.

STUDY HYPOTHESES

Study hypotheses by objective are listed below. All hypotheses are presented as null.

Hypotheses for Objective One

Descriptive statistics will be estimated for patients with CBP and those without. The variables assessed will include age, gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities. All descriptives will be reported as weighted (national) estimates. However, no testable hypotheses are needed for this objective.

Hypotheses for Objective Two

a) National prevalence will be estimated. However, no testable hypotheses are needed for this objective.

b) Prevalence of CBP will be estimated in each subgroup defined on the basis of age (18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and ≥65 years). However, no testable hypotheses are needed for this objective.

c) Prevalence of CBP will be estimated in males and females within each age group defined above. However, no testable hypotheses are needed for this objective.

Hypotheses for Objective Three

Null hypotheses for ambulatory visits by age groups:

i) H_{03Ai}: $AMBV_{CBP18\text{-}24} = AMBV_{NoCBP18\text{-}24}$

In adults between 18 – 24 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

ii) H_{03Aii}: $AMBV_{CBP25\text{-}34} = AMBV_{NoCBP25\text{-}34}$

In adults between 25 – 34 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

iii) H_{03Aiii}: $AMBV_{CBP35\text{-}44} = AMBV_{NoCBP35\text{-}44}$

In adults between 35 – 44 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

iv) H_{03Aiv}: $AMBV_{CBP45\text{-}54} = AMBV_{NoCBP45\text{-}54}$

In adults between 45 – 54 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

v) H_{03Av}: $AMBV_{CBP55\text{-}64} = AMBV_{NoCBP55\text{-}64}$

In adults between 55 – 64 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

vi) H_{03Avi}: $AMBV_{CBP65} = AMBV_{NoCBP65}$

In adults aged 65 years and above, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.

Null hypotheses for hospital inpatient admissions by age groups:

i) H_{03Bi}: $IP_{CBP18\text{-}24} = IP_{NoCBP18\text{-}24}$

In adults between 18 – 24 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

ii) H_{03Bii}: $IP_{CBP25-34} = IP_{NoCBP25-34}$

In adults between 25 – 34 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

iii) H_{03Biii}: $IP_{CBP35-44} = IP_{NoCBP35-44}$

In adults between 35 – 44 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

iv) H_{03Biv}: $IP_{CBP45-54} = IP_{NoCBP45-54}$

In adults between 45 – 54 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

v) H_{03Bv}: $IP_{CBP55-64} = IP_{NoCBP55-64}$

In adults between 55 – 64 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

vi) H_{03Bvi}: $IP_{CBP65} = IP_{NoCBP65}$

In adults aged 65 years and above, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.

Null hypotheses for emergency room visits by age groups:

i) H_{03Ci}: $ER_{CBP18-24} = ER_{NoCBP18-24}$

In adults between 18 – 24 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

ii) H_{03Cii}: $ER_{CBP25\text{-}34} = ER_{NoCBP25\text{-}34}$

In adults between 25 – 34 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

iii) H_{03Ciii}: $ER_{CBP35\text{-}44} = ER_{NoCBP35\text{-}44}$

In adults between 35 – 44 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

iv) H_{03Civ}: $ER_{CBP45\text{-}54} = ER_{NoCBP45\text{-}54}$

In adults between 45 – 54 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

v) H_{03Cv}: $ER_{CBP55\text{-}64} = ER_{NoCBP55\text{-}64}$

In adults between 55 – 64 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

vi) H_{03Cvi}: $ER_{CBP65} = ER_{NoCBP65}$

In adults aged 65 years and above, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.

Null hypotheses for prescription medications by age groups:

i) H_{03Di}: $MEDS_{CBP18\text{-}24} = MEDS_{NoCBP18\text{-}24}$

In adults between 18 – 24 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

ii) H_{03Dii}: $MEDS_{CBP25\text{-}34} = MEDS_{NoCBP25\text{-}34}$

In adults between 25 – 34 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

iii) H_{03Diii}: $MEDS_{CBP35\text{-}44} = MEDS_{NoCBP35\text{-}44}$

In adults between 35 – 44 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

iv) H_{03Div}: $MEDS_{CBP45\text{-}54} = MEDS_{NoCBP45\text{-}54}$

In adults between 45 – 54 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

v) H_{03Dv}: $MEDS_{CBP55\text{-}64} = MEDS_{NoCBP55\text{-}64}$

In adults between 55 – 64 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

vi) H_{03Dvi}: $MEDS_{CBP65} = MEDS_{NoCBP65}$

In adults aged 65 years and above, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.

Hypotheses for Objective Four

Null hypotheses for indirect costs by age groups:

i) H_{04i}: $WRK_{CBP18\text{-}24} = WRK_{NoCBP18\text{-}24}$

In adults between 18 – 24 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

ii) H_{04ii}: $WRK_{CBP25\text{-}34} = WRK_{NoCBP25\text{-}34}$

In adults between 25 – 34 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

iii) H_{04iii}: $WRK_{CBP35\text{-}44} = WRK_{NoCBP35\text{-}44}$

In adults between 35 – 44 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

iv) H_{04iv}: $WRK_{CBP45\text{-}54} = WRK_{NoCBP45\text{-}54}$

In adults between 45 – 54 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

v) H_{04v}: $WRK_{CBP55\text{-}64} = WRK_{NoCBP55\text{-}64}$

In adults between 55 – 64 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

vi) H_{04vi}: $WRK_{CBP65} = WRK_{NoCBP65}$

In adults aged 65 years and above, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.

Hypotheses for Objective Five

Total societal costs, defined here as the sum of total direct medical costs and total indirect costs, will be estimated for persons with CBP. No testable hypothesis is required for this objective.

Hypotheses for Objective Six

The proportion of CBP patients who have visited CAM providers at least once during the study period will be estimated. No testable hypothesis is required for this objective.

Hypotheses for Objective Seven

Null hypotheses for direct costs by age groups:

i) H_{07Ai}: $DIRCOST_{CAM18\text{-}24} = DIRCOST_{NoCAM18\text{-}24}$

In CBP patients between 18 – 24 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

ii) H_{07Aii}: $DIRCOST_{CAM25\text{-}34} = DIRCOST_{NoCAM25\text{-}34}$

In CBP patients between 25 – 34 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

iii) H_{07Aiii}: $DIRCOST_{CAM35\text{-}44} = DIRCOST_{NoCAM35\text{-}44}$

In CBP patients between 35 – 44 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

iv) H_{07Aiv}: $DIRCOST_{CAM45-54} = DIRCOST_{NoCAM45-54}$

In CBP patients between 45 – 54 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

v) H_{07Av}: $DIRCOST_{CAM55-64} = DIRCOST_{NoCAM55-64}$

In CBP patients between 55 – 64 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

vi) H_{07Avi}: $DIRCOST_{CAM65} = DIRCOST_{NoCAM65}$

In CBP patients between 65 years and above, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

Null hypotheses for indirect costs by age groups:

i) H_{07Bi}: $INDCOST_{CAM18-24} = INDCOST_{NoCAM18-24}$

In CBP patients between 18 – 24 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

ii) H_{07Bii}: $INDCOST_{CAM25-34} = INDCOST_{NoCAM25-34}$

In CBP patients between 25 – 34 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

iii) H_{07Biii}: $INDCOST_{CAM35-44} = INDCOST_{NoCAM35-44}$

In CBP patients between 35 – 44 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

iv) H_{07Biv}: $INDCOST_{CAM45-54} = INDCOST_{NoCAM45-54}$

In CBP patients between 45 – 54 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

v) H_{07Bv}: $INDCOST_{CAM55-64} = INDCOST_{NoCAM55-64}$

In CBP patients between 55 – 64 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

vi) H_{07Bvi}: $INDCOST_{CAM65} = INDCOST_{NoCAM65}$

In CBP patients between 65 years and above, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.

METHODOLOGY

Data Source

Files from the Medical Expenditure Panel Survey (MEPS) database, maintained by Agency for Healthcare Research and Quality (AHRQ), were used for this study.[48] The National Medical Expenditure Survey was renamed Medical Expenditure Panel Survey in 1996. MEPS is "...a set of large-scale surveys of families and individuals, their medical providers (doctors, hospitals, pharmacies, etc.), and employers across the United States."[49] Key variables on which data are collected include demographics (e.g., age, gender, race, marital status, education, and poverty status), healthcare expenditure variables (e.g., total charges, insurance payments, copayments, and out-of-pocket payments), employment information, health status information (e.g., physical limitations, mental impairment, and activity limitations), and healthcare utilization (including services used, medications prescribed, and charges).

Survey Components

MEPS consists of mainly three components: Household (HC), Medical Provider (MPC), and Insurance Component (IC). Of these, HC files are publicly available and were used for this study.

Household Component (HC)

MEPS-HC is an annual survey of approximately 14,000 American households that can be used to compute national estimates of health care use, expenditures, insurance coverage, health status, and sources of payment.[50] MEPS provides person-weights to compute national estimates from the included respondents. MEPS-HC is administered to a subsample of respondents from the previous year's National Health Interview Survey (NHIS) and is representative of the civilian, non-institutionalized population of the

United States. The survey is conducted using a panel design (Figure 2-1) that will be discussed in further detail in the next section. MEPS-HC public use files (PUF) are available for download from the MEPS website and are provided as separate person-level, event-level, condition-level, and job-level files that need to be linked before use.

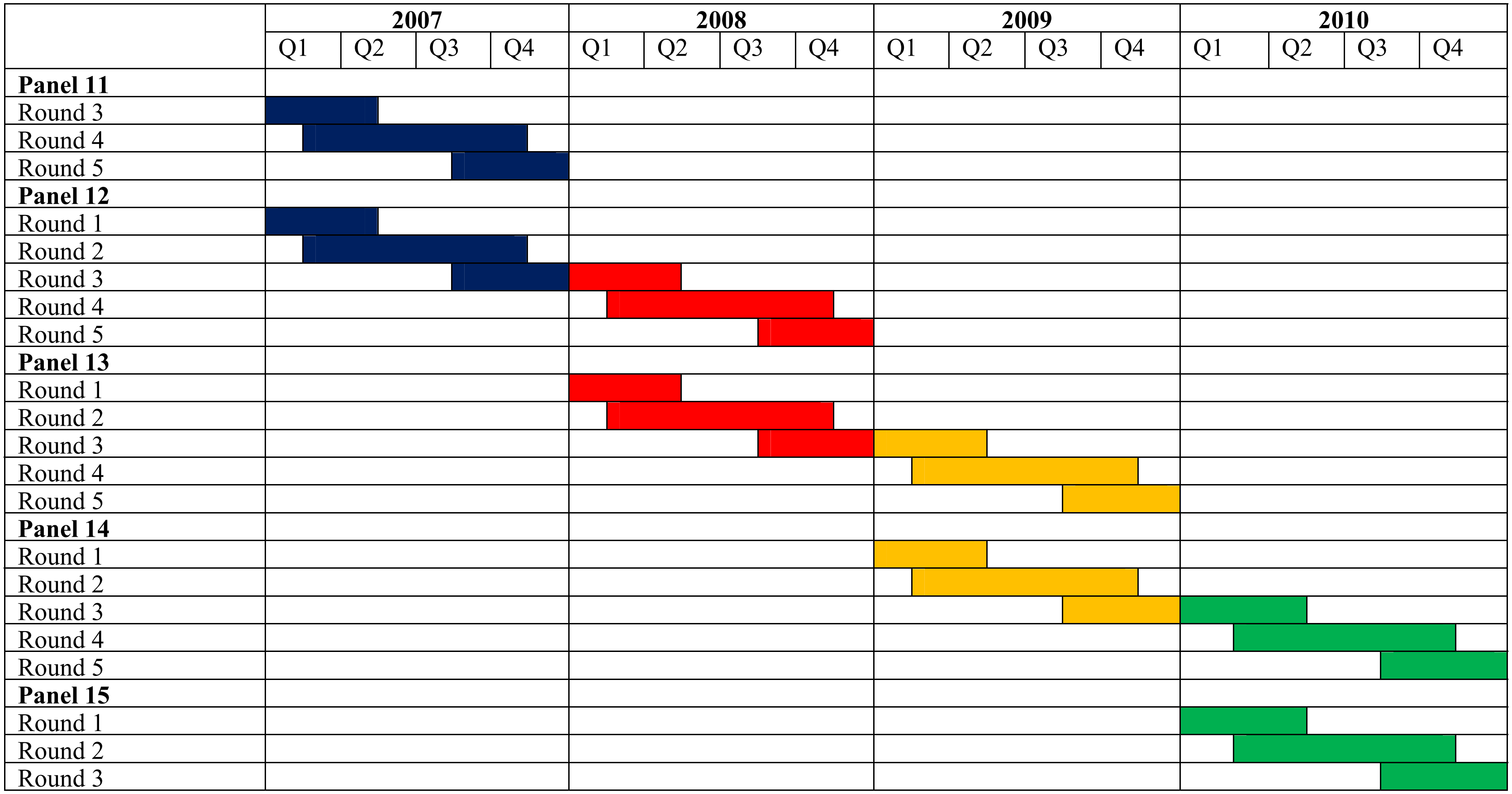
Insurance Component (IC)

Also known as the Health Insurance Cost Study, this component of MEPS consists of data collected from a sample of employers (both private and public sector) on the health insurance they offer to employees. The information collected includes premiums paid, benefits of health insurance plans offered, contribution towards health benefits by employers and employees, as well as eligibility criteria. However, IC files are not publicly available.

Medical Provider Component (MPC)

This component involves data collection to supplement and/or replace MEPS-HC data. Data for this component are collected from hospitals, physicians, home health care providers and pharmacies. Respondents of MEPS-HC identify the respondents for MEPS-MPC. Information from this component is used to impute missing information in MEPS-HC or to correct it in case of uncertain veracity.

Figure 2-1. MEPS Panel design: data reference periods



Panel design and data collection

As mentioned earlier, MEPS-HC is a nationally representative household survey of non-institutionalized, civilian Americans. Interviews are conducted using computer-assisted personal interviewing (CAPI) and include multiple sections and query modules. Since all questions might not be applicable to each individual, the CAPI program includes a complex skip-pattern that determines which questions to ask based on previous responses.

Figure 2-1 illustrates the overlapping panel design of the survey. A panel is the set of households included in the sample and a new one is selected every year. Data are gathered for each individual in the included household from a single respondent. Each panel is followed for two years (from January 1 of the first calendar year to December 31 of the second calendar year), with data being collected in five rounds of interviews conducted over two-and-a-half years. Due to the overlapping design of the panels, PUFs for each year contain data from two panels. For example, as shown in Figure 3.1, 2009 PUFs include data from Rounds 3 (partial), 4, and 5 of Panel 13, and Rounds 1, 2, and 3 (partial) of Panel 14. The period for which data are collected during an interview round is known as the 'reference period'. Taking Panel 14 as an example, for Round 1, the reference period covers the time period from January 1, 2009 to the interview date. For Round 5, the reference period covers the time period from the interview date for Round 4 to December 31, 2010. For Rounds 2, 3, and 4, the reference period is the time between the interview date of the previous round and the date of current interview administration.

Household Component Public Use Files

The Full-Year Consolidated Files, Event Files, Medical Conditions Files, as well as Longitudinal Data Files comprise publicly available files from the MEPS-HC component. The following files were used for the purposes of this study:

- Longitudinal Data File – This files contain data organized by panel and can be used for longitudinal analysis. Information for all 5 rounds and 2 years for each individual is included in this file. Data on population characteristics like unique person identifier, demographics, income information, missed workdays, health insurance, health status, healthcare utilization, and expenditures, are included in this file.
- Medical Conditions File – This is a condition-level file with each record indicating a unique medical condition represented by a unique identifier (CONDIDX). Each condition can be linked to a medical event (prescribed medicine, physician visit, inpatient admission, emergency room visit) using a unique event identifier, EVNTIDX. Each condition record also includes the unique person identifier, DUPERSID, which can be used to link the record to a person's record in the Longitudinal Data File. Information on the medical condition is included in the form of ICD-9-CM (*International Classification of Diseases, 9th Revision, Clinical Modification*) diagnosis codes as well as the Clinical Classification Code.

The specific files that were downloaded are listed in Table 2-1.

Table 2-1. MEPS files to be used for proposed study

Panel	Years data collected	Longitudinal data Files	Medical Conditions Files
12	2007-2008	HC-122	HC-112, HC-120
13	2008-2009	HC-130	HC-120, HC-128
14	2009-2010	HC-139	HC-128, HC-137

Data set

Data from Panels 12, 13, and 14 were used for this study. Together, the three panels include data from January 1, 2007 to December 31, 2010. The unweighted number of persons who were in-scope for the survey and with available information for all 5 rounds were 11,348; 16,526; and 14,833 for Panels 12, 13, and 14, respectively. The files that were used to complete this study are tabulated in Table 2-1.

The Longitudinal Data Files include a weight variable (LONGWT) that allows computation of national estimates for healthcare utilization and expenditures. Since 3 panels were combined, LONGWT for each individual was divided by 3, as recommended by AHRQ (personal correspondence with AHRQ Data Center staff). Attrition, non-response, and imputations are all taken into account during the construction of LONGWT. Besides appropriate weighting, the complex sampling design of MEPS was also taken into account to get accurate estimates and standard errors. This was achieved by using "svy:" procedure commands during statistical analysis with Stata SE 12.0 (StataCorp LP, College Station, TX, USA).

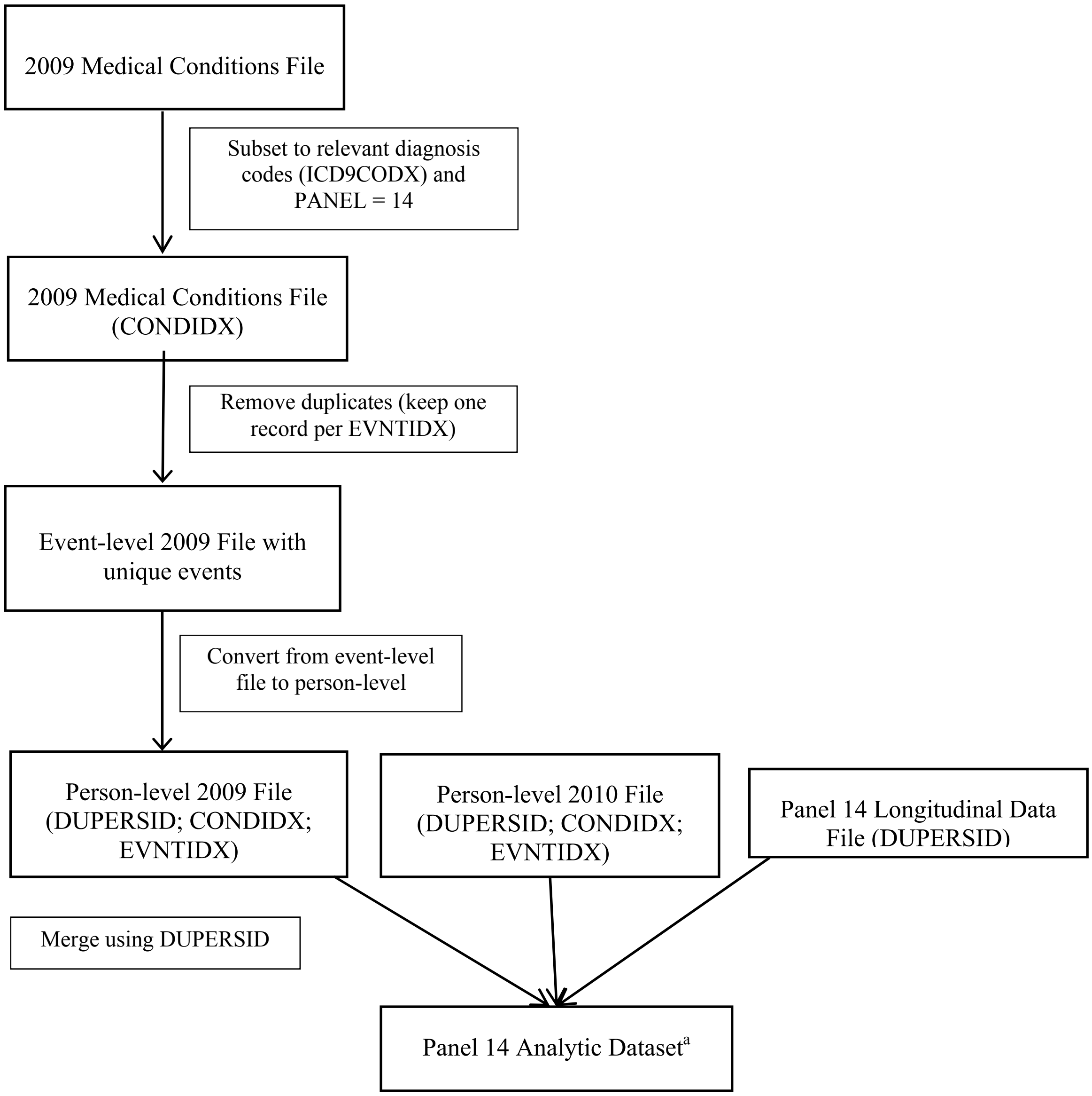
Procedure to link data files

The Medical Conditions and Longitudinal Data Files were linked to build the analytic dataset. The linkage process is illustrated in Figure 2-2 below using Panel 14 as an example. Similar linkage was carried out to build analytic datasets for Panels 12 and 13. Once analytic datasets for individual panels were constructed, they were combined to obtain the final analytic dataset.

The 2009 and 2010 data files were used to construct the Panel 14 dataset (Figure 2-2). The specific steps are listed below:

1. Use the 2009 Medical Conditions file and subset to records with PANEL = 14 and ICD9CODX associated with back pain (Table 2-2).
2. Remove all duplicate observations from the resulting dataset (i.e., keep one observation per EVNTIDX).
3. Convert the consolidated event-level file to person-level.
4. Repeat steps 1-3 for the 2010 files.
5. Merge the 2009 and 2010 person-level files with the Panel 14 Longitudinal Data File using DUPERSID.
6. Follow steps similar to 1-5 for Panel 12 (years 2007-2008) and Panel 13 (years 2008-2009).
7. Combine Panels 12, 13, and 14 files to obtain final analytic dataset for the study.

Figure 2-2. Procedure to link data files for MEPS Panel 14



Note: Illustrated with 2009 files; similar linkage necessary for 2010 files.
[a]Analytic dataset for Panel 14 will be combined with similar datasets for Panels 12 and 13 to obtain the Study Analytic Dataset

Identification of cases and controls

Individuals 18 years and older, having positive values longitudinal weight (LONGWT) variables, and who were "in-scope" with available data for all five rounds of interviews were included in this study.

As mentioned earlier, this research project was originally constructed to assess the burden of chronic **lower** back pain. Persons with lower back pain were identified using ICD-9-CM (*International Classification of Diseases, 9th Revision, Clinical Modification*) codes and related diagnoses that were used to identify persons with a disorder definitely associated with low back pain are presented in Table 2-2 (721.3x, 721.42, 722.10, 722.32, 722.52, 722.73, 722.83, 722.93, 724.02, 724.03, 724.2x, 724.3x, 724.6x, 724.7x, 738.4x, 739.3x, 739.4x, 756.11, 756.12, 846.xx, 847.2x, and 847.3x). The definite association of these disorders with low back pain has been established and validated by Cherkin et al.[51] and has been used in numerous studies thereafter.[52,53] Any person with the above-mentioned codes in the primary or secondary diagnoses fields of the Medical Conditions Files was identified as having low back pain.* After running preliminary analysis, a very small proportion of the population was found reporting low back pain specifically (unweighted N = 290 compared to unweighted N = 45,711 in the Control group). Due to this gross imbalance in group sizes, an expanded population was used – made up of patients that reported back (not localized to lower back) and neck problems (Table 2-3), similar to the patient identification criterion used by Martin et al.[4]

*MEPS includes only 3-digit ICD-9-CM diagnosis codes in public use files. Access to 5-digit codes was granted by AHRQ and required travel to the Data Center in Rockville, MD, USA.

Table 2-2. International Classification of Disease Codes and related diagnoses to identify persons reporting **lower back pain**

ICD-9-CM code	Diagnosis
721.3	Lumbosacral spondylosis without myelopathy
721.42	Lumbar spondylosis with myelopathy
722.10	Intervertebral disc disorder - Lumbar intervertebral disc without myelopathy
722.32	Schmorl’s Nodes – Lumbar region
722.52	Intervertebral disc disorder - Degeneration of lumbar or lumbosacral intervertebral disc
722.73	Intervertebral disc disorder - Lumbar intervertebral disc with myelopathy
722.83	Intervertebral disc disorder - Postlaminectomy syndrome – Lumbar region
722.93	Other and unspecified disc disorder – Lumbar region
724.02	Spinal stenosis – Lumbar region
724.2	Lumbago
724.3	Sciatica
724.6	Disorders of sacrum
724.7x	Disorders of coccyx
- 724.70	Unspecified disorder of coccyx
- 724.71	Hypermobility of coccyx
- 724.79	Other disorder of coccyx – coccygodynia
738.4	Acquired spondylolisthesis
739.3	Nonallopathic lesions, lumbar region
739.4	Nonallopathic lesions, sacral region
756.11	Spondylolysis, lumbosacral region
756.12	Spondylolisthesis
846	Sprains and strains of sacroiliac region
847.2	Sprains and strains, lumbar
847.3	Sprains and strains, sacral

Table 2-3. International Classification of Disease Codes and related diagnoses to identify persons reporting **general back and neck pain**

ICD-9-CM code	Diagnosis
720	Ankylosing spondylitis and other inflammatory spondylopathies
721	Spondylosis and allied disorders
722	Intervertebral disc disorders
723	Other disorders of cervical region
724	Other and unspecified disorders of back
737	Curvature of spine
805	Fracture of vertebral column without mention of spinal cord injury
806	Fracture of vertebral column with spinal cord injury
839	Other, multiple, and ill-defined dislocations of spine
846	Sprains and strains of sacroiliac region
847	Sprains and strains of other and unspecified parts of back

The next step was to identify patients meeting the criteria for chronicity of back pain. As mentioned earlier, there is no consensus on the definition of chronicity of back pain. Some researchers report back pain as being chronic if it is present continuously for 3 months while other identify chronic back pain as pain present for 6 months or more. Interview rounds of MEPS are between 3 to 6 months apart. Thus, it was decided to examine chronic back pain defined in two different ways. Records of persons identified as having back pain were examined after the formation of the final analytic dataset. Only those individuals reporting back pain in three continuous rounds of interviews (out of a possible five rounds) were identified as suffering from chronic back pain. This is similar to the approach used by Smith.[54] Using three continuous rounds of back pain for identification of CBP patients was used to minimize the inclusion of persons with acute, recurrent back pain and restricts the CBP group to persons with long-term back pain. Persons who did not report back pain in any MEPS round were included in the Control group. For the purposes of a sensitivity analysis an "Alternate" Chronic Back Pain (ACBP) group was also extracted. The ACBP group included those individuals who reported back pain in at least 2 consecutive MEPS interview rounds.

Table 2-4. Patient inclusion criteria and group assignment

Group	Original Analysis Definition	Alternate Analysis Definition
Control (same for both)	No back pain in any round	No back pain in any round
Chronic Back Pain	Back pain in 3 consecutive rounds (CBP)	Back pain in 2 consecutive rounds (ACBP)

The analyses of interest were the excess costs for the CBP and ACBP groups over the Control group.

Study Variables

This section includes operational definitions of all dependent and independent variables, as well as subgroup variables and covariates.

Dependent variables

Direct Medical Costs

Direct medical costs include expenditure/payments from all sources on inpatient stays, outpatient and office visits, emergency care, and prescription medications. There are 12 sources of payment that are considered when creating MEPS expenditure variables: self, Medicaid, Medicare, private insurance, Veterans Administration, Tricare, other federal sources, state and local government, workers compensation, other private sources, other public sources, and other sources of insurance. Direct medical costs listed above were obtained from the MEPS Longitudinal Data Files.

Indirect costs

Indirect costs include costs of lost productivity due to missing work. The hourly wage was multiplied by 8 to obtain the daily wage rate (assuming an 8-hour work day).

This product was then be multiplied by the number of workdays missed due to illness or disability or staying in bed to calculate the total lost productivity.

Independent variables

Presence of CBP

Persons identified as having CBP and those without were coded as follows: 1 – CBP present; and 0 – control group – no back pain in any round. A similar indicator variable was constructed for patients included in the ACBP group.

Utilization of provider-based CAM

Provider-based CAM includes utilization of chiropractic care, acupuncture treatments, or massage therapy. A categorical variable (CAMUTIL) was constructed to indicate utilization of provider-based CAM. Persons with CBP who use provider-based CAM at least once in the study period was coded as '1' on the indicator variable, and those who do not utilize provider-based CAM at least once during the study period was coded as '0'.

Subgroup variables

Age

Age was operationally defined as age in the first round of interview (AGE1X), as reported in the Longitudinal Data Files for each panel. Age was categorized into 6 subgroups: 18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and ≥65 years. These groups were used to stratify the study population. Comorbidity profiles differ by age and an overall excess cost computation without controlling for age might result in misestimating the economic burden of CBP.

Note: MEPS top-codes age variables at 85 years to maintain confidentiality.

Covariates

Gender

Gender information is included in the Longitudinal Data Files as the categorical variable SEX. This variable is coded as '1' for male gender, and '2' for female gender. Determination of gender for each individual is carried forward from the National Health Interview Survey (NHIS) of the previous year (e.g., families entered MEPS Panel 14 in 2009 and their sex was determined on the basis of responses in the 2008 NHIS interview) and verified during MEPS interview. For the purposes of this study, a new categorical variable, FEMALE, was created with the value '0' indicating male gender, and '1' indicating female gender.

Race

Information on race and ethnicity was obtained from the categorical variable RACE included in the Longitudinal Data Files. The categories include: White, Black, American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and Multiple Race reported.

Insurance status

A categorical insurance status variable was generated using information from the Longitudinal Data Files. These files have 2 insurance status summary variables – insurance coverage indicators for panel year 1 (INSCOVY1) and year 2 (INSCOVY2). Both variables are coded as: 1 – Any Private (private insurance coverage, including TRICARE, for at least one day of one month during the year); 2 – Public Only (only public insurance coverage during the year); or 3 – Uninsured (person was uninsured during the year). As can be seen from the definitions of the categories, a person is coded as having private coverage even if it is only for a day during the year. A categorization as 'uninsured' is a categorization of exclusion (i.e., if a person reports not having either, public or private insurance, then he/she is coded as being uninsured). A person is considered publicly insured for the year in two scenarios – if he is publicly insured for part of the year and uninsured for the rest of the year, or if he has public insurance for the whole year.

In keeping with the definitions adopted in MEPS, the generated variable was coded in the following way: 1 – Any Private (coded as having private insurance coverage, including TRICARE, either in year 1 or year 2, or both); 2 – Public Only (coded as having only public insurance coverage during both, year 1 and year 2); or 3 – Uninsured (coded as being uninsured during both years).

US Census Region

Census Region of respondent was obtained from the categorical variable REGIONY2 and defined as the US Census Region of residence as of December 31 of the last year of the panel. The four Census Regions are: Northeast, Midwest, South, and West.

Self-reported health status and disability measures

Information on self-reported health status and disability measures is included in the Longitudinal Data Files. The following measures/variables were assessed:

- **Limitations in activities of daily living (ADL)**

  Activities of daily living are defined as activities referring to personal care including bathing and dressing, or getting around the house. Questions about receiving help for ADL were asked in all 5 rounds of the MEPS-HC. For the purposes of this study, a new categorical variable was created (ADLPRES – presence of limitations in activities of daily living), and coded as: 1 – person receives help or supervision for ADL in at least one of the 5 rounds; and 0 – person does not receive help or supervision for ADL.

- **Functional limitations**

  Functional limitations are defined as difficulty in performing specified activities like walking, climbing stairs, grasping objects, reaching overhead, lifting, bending or stooping, or standing for long periods of time. Inquiries about functional limitations are made in MEPS Rounds 1, 3, and 5. For this study, a new categorical variable was created (FLPRES – presence of functional limitations), and coded as: 1 – person has difficulty in walking, climbing stairs, grasping objects, reaching overhead, lifting, bending or stooping, or standing for long periods of time in at least one of the 3 inquiry rounds; and 0 – person does not report difficulty in walking, climbing stairs, grasping objects, reaching overhead, lifting, bending or stooping, or standing for long periods of time in any of the 3 inquiry rounds.

- **Social limitations**

  Social/recreational limitations are defined as limited participation in social, recreational, or family activities due to a physical or mental impairment. Information on such limitations is collected in Rounds 1, 3, and 5. In this study, a new categorical variable was created (SOCPRES – presence of social/recreational limitations), and coded as: 1 – person reports limited participation in social, recreational, or family activities due to a physical or mental impairment in at least one of the 3 inquiry rounds; and 0 – person reports limited participation in social, recreational, or family activities due to a physical or mental impairment in none of the 3 inquiry rounds.

- **Work, school, or housework limitations**

  Inquiries about work, school, and housework limitations are made in Rounds 1, 3, and 5. A categorical variable was created (ACTLIMPRES – presence of work, school, or housework limitations), and coded as: 1 – person reports limitations in work, school, or housework activities due to a physical or mental impairment in at least one of the 3 inquiry rounds; and 0 – person reports limitations in work, school, or housework activities due to a physical or mental impairment in none of the 3 inquiry rounds.

- **SF-12 component summary variables**

  MEPS-HC includes questions from Short Form – 12, Version 2 (SF-12v2). Two summary variables based on responses to SF-12v2 are included in the Longitudinal Data Files. The SF-12v2 is administered as part of MEPS-HC in Rounds 2 and 4. Thus, the Longitudinal Data Files contain two Physical Component Summary (PCS) and Mental Component Summary (MCS) scores each. For this study, a continuous variable was constructed (PCSMN) that comprises the mean PCS score for each person. A similar variable will also be constructed for the mental component summary score for each person (MCSMN).

Number of comorbidities

A continuous variable was constructed using AHRQ's Clinical Classification Codes to indicate the number of comorbidities present. This code groups ICD-9-CM diagnosis codes to create comorbidity variables. For example, 29 ICD-9 diagnosis codes can be used to identify various liver disorders; this software classifies any record having one of these diagnosis codes as having 'liver disease'. This information was obtained from the Medical Conditions Files for the three Panels.

Analysis Plan for Specific Objectives

All data management and analyses were carried out using Stata SE 12.0 (StataCorp LP, College Station, TX, USA), taking the complex sampling design of the data into consideration. All expenditures were adjusted to 2011 US Dollars using appropriate Consumer Price Indices (CPI) published by the Bureau of Labor Statistics. Specifically, we used the Physician Services CPI for costs of ambulatory care, Inpatient Services CPI for inpatient admission costs, Hospital Services CPI for emergency room visit costs, and Prescription Medications CPI for prescription medication costs. The a priori alpha level was set at **0.01** and all tests were two-tailed. An alpha level of 0.01 was considered more appropriate than 0.05 due to the large number of planned analyses. The analysis plan for each objective is presented below.

1. **To report aggregate statistics/measures of demographic characteristics of individuals with CBP in the community-dwelling, adult population of the United States. These characteristics include age, gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities.**

   Means and standard errors were computed for continuous variables using the "svy: mean" procedure. Frequencies and percentages were computed using the "svy: tab" procedure for categorical variables. All frequencies will be reported as national estimates using the sampling weights given.

2. **To estimate the prevalence of CBP in the community dwelling, adult population of the United States.**
   - **To estimate national prevalence of CBP in community-dwelling US adults.**
   - **To estimate the prevalence of CBP in the community dwelling, adult population of the US, stratified by age group (18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and ≥65 years).**

- **To estimate the prevalence of CBP in males and females in the community dwelling, adult population of the US, stratified by age group.**

Various prevalence estimates (overall, stratified by age, and by gender) was computed using the "svy: proportion" procedure.

3. **To estimate national mean excess direct medical costs of CBP per person stratified by age, after controlling for demographic and clinical factors, and using the incremental cost approach.**

Overall excess direct costs of persons with CBP were estimated using a generalized linear model (GLM) with a gamma distribution function and log link. Typically, cost data have a right-skewed distribution with a long tail on the upper end. Gamma distributions are ideally suited to fit such data. The fit was confirmed with the Modified Park's test.[55] This test was carried out by estimating a gamma regression model and then using the predicted values to compute residuals to use in the linear regression:

$$Log((y-\hat{y})^2)=\gamma_0+\gamma_1(\log(\hat{y}))+\varepsilon$$

where: y - outcome variable

$\hat{y}$ - predicted values of outcome variable

γ_1 (Park's coefficient) values are reported with the results for each model.

A separate GLM was constructed for each age group to determine excess direct costs within that subgroup. The dependent variable for these models was direct medical costs (total costs due to inpatient stays, outpatient and office visits, emergency care, and prescription medications). Presence of CBP was used as the independent variable. Gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities were used as covariates in the models.

a. **To estimate national mean excess costs per person, stratified by age, for office-based and hospital outpatient department physician visits (ambulatory visits) between individuals with CBP and those without.**

Similar to the approach for overall excess direct costs, a GLM was constructed for each age group. The sum of costs for office-based and hospital outpatient department physician visits was the dependent variable. The independent variable and covariates will be the same as the overall direct medical cost models.

b. **To estimate national mean excess costs per person, stratified by age, for hospital inpatient admissions between individuals with CBP and those without.**

A two-part regression model for each age group was constructed to estimate excess mean inpatient costs for persons with CBP. The "svy: tpm" procedure was used towards this purpose, and a separate model was used to analyze costs within each age group.

The first part of the model was a logistic regression model with the outcome variable being the conditional probability of having non-zero inpatient admission costs, given the set of independent covariates. The second part of the model was a GLM with a gamma distribution and log link. The outcome variable estimated by the GLM was hospital inpatient admission costs, given the set of independent covariates.

The specific parts of the regression model are as follows:

A. $P(Y > 0)| X) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}$, where:

$P(Y > 0)| X)$ is the conditional probability of having non-zero costs;

X1 is gender;

X2 is race;

X3 is US Census region;

X4 is insurance status;

X5 is presence of ADL limitations;

X6 is presence of functional limitations;

X7 is presence of social limitations;

X8 is presence of work, school, or housework limitations;

X9 is SF-12v2 Physical Component Summary (PCS) score;

X10 is SF-12v2 Mental Component Summary (MCS) score;

and X11 is number of comorbidities.

B. $g(E(Y|Y > 0, X)) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11}$, where:

g is the link function for the GLM;

and $E(Y|Y > 0, X)$ is the predicted costs conditional on incurring any costs.

Thus, the two-part model can be represented as:

$E(Y|X) = P(Y > 0)| X) . E(Y|Y > 0, X)$, where $E(Y|X)$ is the predicted value of costs.

c. To estimate national mean excess costs per person, stratified by age, for emergency room visits between individuals with CBP and those without.

Excess mean emergency room costs for persons with CBP was estimated using regression modeling similar to the approach used for hospital inpatient admission excess costs (2-part model).

d. **To estimate national mean excess costs per person, stratified by age, for prescription medications between individuals with CBP and those without.**

Prescription medication costs were assessed using regression models similar to the ones used for physician visits.

4. **To estimate national mean excess indirect costs (lost productivity based on the number of work-days the person lost due to illness or injury) of CBP per person stratified by age, after controlling for demographic and clinical factors, and using the incremental cost approach.**

Two-part regression models (separate ones for each age group) were developed to compute an estimate of the mean, adjusted excess indirect costs of persons with CBP using the "svy: tpm" procedure. The covariates included in the model were the same as the ones used in the analyses for Objective 3. Similar to the hospital inpatient admissions costs model, the first part of the model was a logistic regression model with the outcome variable being the conditional probability of having non-zero indirect costs, given the set of independent covariates. The second part of the model was a GLM with gamma distribution and log link.

5. **To compute an estimate of total national societal costs (direct medical + indirect) of CBP.**

A national estimate of unadjusted total societal costs of CBP was computed using the "svy: total" procedure.

6. **To estimate the proportion of CBP patients who have visited CAM providers at least once during the study period.**

The proportion of CBP patients utilizing provider-based CAM was estimated using the "svy: proportion" procedure.

7. **To estimate and compare national mean total direct medical and indirect costs between CBP patients who use provider-based CAM services at least once during the study period and those who did not use such services.**

This objective was achieved with the utilization of separate generalized linear models (GLM) for direct and indirect costs (all stratified by age). The independent variable for these models was CAMUTIL (indicator variable for utilization of provider-based CAM services). Demographic, clinical, and health status variables were included as covariates in model construction, enabling computation of adjusted mean cost estimates for both groups.

Chapter 3: Results

As outlined in the Methods section, all estimates were weighted using the weight, stratification, and complex sampling design variables provided in the dataset; all cost estimates are presented in 2011 US dollars, and p-values of ≤0.01 were considered statistically significant.

DESCRIPTIVES

Prevalence of chronic back pain in the community-dwelling US adult population

Prevalence estimates for back pain in the community-dwelling US adult population are presented in Table 3-1. The number of community-dwelling US adults with information available from all five MEPS rounds was approximately 215.1 million. Of those, the number that reported back pain in at least two consecutive rounds was 15.3 million [proportion = 7.10%; 95% CI = 6.70-7.50] (Alternate Chronic Back Pain - ACBP group), and those that reported back pain consecutively in at least three of the five rounds was approximately 8.08 million [proportion = 3.76%; 95% CI = 3.41-4.10] (Chronic Back Pain - CBP group). Table 3-2 shows the prevalence of CBP and ACBP within the six age groups under consideration (18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and ≥65 years). As can be seen from the table, the proportion of adults reporting chronic back pain (CBP) increases with age from approximately 1% in 18-24 year olds to approximately 5.4% in 55-64 year olds. In older adults (≥65 years), the prevalence of CBP is approximately 5%.

Table 3-1. Proportion of community-dwelling US adult population reporting back pain

Group	Proportion of community-dwelling US adult population	95% C.I.	
		Lower	Upper
Chronic Back Pain (CBP) group[b]	3.76%	3.41%	4.10%
Alternate Chronic Back Pain (ACBP) group[c]	7.10%	6.70%	7.50%

a: Divisor = 215.1 million

b: Persons reporting back pain in 3 or more consecutive rounds

c: Persons reporting back pain in 2 or more consecutive rounds

Table 3-2. Proportion of US adult population reporting chronic back pain in each age group

Age Group	Proportion within age group reporting CBP[a] (95% CI)	Proportion within age group reporting ACBP[b] (95% CI)
18 – 24	1.03% (0.62-1.44)	2.43% (1.80-3.06)
25 – 34	1.71% (1.26-2.17)	4.24% (3.63-4.85)
35 – 44	3.80% (3.14-4.46)	7.14% (6.29-7.99)
45 – 54	5.03% (4.25-5.81)	8.72% (7.79-9.65)
55 – 64	5.42% (4.57-6.27)	9.48% (8.43-10.54)
≥65	5.02% (4.18-5.87)	9.74% (8.78-10.70)

a: Persons reporting back pain in 3 or more consecutive rounds

b: Persons reporting back pain in 2 or more consecutive rounds

Population characteristics

Descriptive characteristics of the population under consideration are presented in Tables 3-3 (categorical variables) and 3-4 (continuous variables). Approximately 59% of the persons reporting chronic back pain were females compared with 52% for the overall US adult population. Persons in the age group 45-54 years (20.0% of the overall population) made up the largest proportion of the chronic back pain group at 26.7%, followed by adults aged 55-64 years (15.3% of the overall population) at 22.1%. Adults aged 18-24 years old (12.5% of the overall population) made up the smallest proportion of the CBP group at 3.4%. Approximately 22% of overall population lived in the Midwest but made up 26% of the CBP group. Almost 70% of the CBP group was insured privately, and more than 89% were White. A majority (61%) of persons with chronic back pain reported having at least some functional limitations (defined as difficulty in performing specified activities like walking, climbing stairs, grasping objects, reaching overhead, lifting, bending or stooping, or standing for long periods of time) compared with 19% of the overall population.

Examination of continuous variables (Table 3-4) revealed that persons reporting chronic back pain are older than the overall population (mean age = 52.3 years vs. 45.7 years); and have more comorbidities (mean = 11.3) compared to the overall US adult population (mean = 6.1). The CBP group also scored lower, on average, on both SF-12 (version 2) component summary scores [Physical Component Summary (PCS) scores – 37.97 in CBP group vs. 49.14 in the overall population; Mental Component Summary (PCS) scores – 47.27 in CBP group vs. 50.72 in the overall population], indicating a poorer quality of life.

Table 3-3. Descriptive characteristics of community-dwelling US adult population with information recorded in all 5 MEPS rounds (Categorical Variables only)

Categorical Variable	Chronic back pain group[a] (Weighted N=8,081,118)		Alternate Chronic Back Pain group[b] (Weighted N=15,274,308)		Overall population (Weighted N=215,179,978)	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Gender						
Male	3,306,077	41.0%	6,523,923	43.0%	103,451,141	48.0%
Female	4,775,041	59.0%	8,750,385	57.0%	111,728,837	52.0%
Age group						
18-24 years	278,328	3.4%	655,271	4.3%	26,985,581	12.5%
25-34 years	672,269	8.3%	1,664,200	10.9%	39,221,156	18.2%
35-44 years	1,510,982	18.7%	2,839,659	18.6%	39,764,628	18.5%
45-54 years	2,160,892	26.7%	3,745,442	24.5%	42,950,097	20.0%
55-64 years	1,787,621	22.1%	3,128,783	20.5%	32,986,902	15.3%
≥65 years	1,671,026	20.7%	3,240,952	21.2%	33,271,614	15.5%
Race						
White	7,186,627	89.0%	13,534,762	89.0%	175,888,712	82.0%
Black	509,267	6.3%	966,068	6.3%	24,308,628	11.0%
American Indian/Alaska Native	56,345	0.7%	82,595	0.5%	1,661,107	0.8%
Asian	141,077	1.7%	368,895	2.4%	9,677,262	4.5%

Table 3-3 (continued). Descriptive characteristics of community-dwelling US adult population with information recorded in all 5 MEPS rounds (Categorical Variables only)

Categorical Variable	**Chronic back pain group[a] (Weighted N=8,081,118)**		**Alternate Chronic Back Pain group[b] (Weighted N=15,274,308)**		**Overall population (Weighted N=215,179,978)**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Native Hawaiian/Pacific Islander	21,323	0.3%	25,892	0.2%	536,831	0.3%
Multiple races reported	166,481	2.1%	296,094	1.9%	3,107,439	1.4%
US Census Region						
Northeast	1,394,756	17.0%	2,780,323	18.2%	39,548,481	18.4%
Midwest	2,120,626	26.0%	3,817,665	25.0%	47,294,624	22.0%
South	2,532,096	31.0%	4,750,085	31.1%	78,803,574	36.6%
West	2,033,640	25.0%	3,926,234	25.7%	49,533,299	23.0%
Insurance coverage						
Private	5,606,127	69.4%	11,144,405	73.0%	154,646,888	71.9%
Public	1,854,114	22.9%	3,058,046	20.0%	33,398,416	15.5%
Uninsured	620,877	7.7%	1,071,857	7.0%	27,134,674	12.6%
Limitations in activities of daily living (ADL)						
Yes	737,549	9.1%	1,171,965	7.7%	6,840,307	3.2%
No	7,343,569	91.0%	14,102,343	92.0%	208,339,671	97.0%
Functional limitations						
Yes	4,889,217	61.0%	7,647,098	50.0%	41,932,552	19.0%
No	3,191,902	39.0%	7,627,210	50.0%	173,247,426	81.0%

Table 3-3 (continued). Descriptive characteristics of community-dwelling US adult population with information recorded in all 5 MEPS rounds (Categorical Variables only)

Categorical Variable	Chronic back pain group[a] (Weighted N=8,081,118)		Alternate Chronic Back Pain group[b] (Weighted N=15,274,308)		Overall population (Weighted N=215,179,978)	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Social/recreational limitations						
Yes	2,734,385	34.0%	3,849,733	25.0%	18,878,182	8.8%
No	5,346,734	66.0%	11,424,574	75.0%	196,301,796	91.0%
Work, school, or housework limitations						
Yes	3,518,465	44.0%	5,292,083	35.0%	28,603,393	13.0%
No	4,562,654	56.0%	9,982,225	65.0%	186,576,585	87.0%

a: Persons reporting back pain in 3 or more consecutive rounds

b: Persons reporting back pain in 2 or more consecutive rounds

Table 3-4. Descriptive characteristics of community-dwelling US adult population with information recorded in all 5 MEPS rounds (Continuous Variables only)

Continuous Variable	Chronic back pain group[a] (Weighted N=8,081,118)	Alternate Chronic Back Pain group[b] (Weighted N=15,274,308)	Overall population (Weighted N=215,179,978)
	Mean (SE)	**Mean (SE)**	**Mean (SE)**
Age	52.27 (0.60)	51.41 (0.46)	45.71 (0.23)
# of comorbidities	11.30 (0.25)	10.56 (0.19)	6.08 (0.05)
SF-12 v.2 outcomes[c]			
Physical component summary (PCS) score	37.97 (0.49)	40.74 (0.36)	49.14 (0.11)
Mental component summary (MCS) score	47.27 (0.44)	48.68 (0.32)	50.72 (0.08)

a: Persons reporting back pain in 3 or more consecutive rounds
b: Persons reporting back pain in 2 or more consecutive rounds
c: Lower scores indicate lower health-related quality of life

COSTS OF BACK PAIN

DIRECT MEDICAL COSTS

The direct medical costs assessed in this study include costs for ambulatory visits, inpatient admissions, emergency room visits, and prescription medications. All direct costs are stratified by the pre-specified age groups and are presented in 2011 US dollars. The overall excess direct costs over 2 years per person was estimated at $37,129 ($48,586 vs. $11,458; p<0.001), after controlling for demographic and clinical covariates.

Excess cost of ambulatory visits in persons reporting back pain stratified by age group

The mean excess cost over 2 years for ambulatory visits was estimated at $11,711 ($14,929 vs. $3,219; p<0.001) per person.

Excess cost of ambulatory visits in persons aged 18-24 years old reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.92, and indicative of a gamma distribution. A generalized linear model with a gamma distribution and log link was used with the following covariates: age, gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities. Adjusted costs for the CBP and Control groups are presented in Table 3-5. When compared with persons not reporting back pain over the study period (Control group), persons with chronic back pain had a statistically significantly higher mean cost for ambulatory visits [Difference = US$11,712 (95% CI: $3,866-$19,559; p=0.004)] over two years per person.

Thus, H03Ai: $AMBV_{CBP18-24} = AMBV_{NoCBP18-24}$ (Hypothesis 3a-i) was rejected.

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$6,844 (95% CI: $3,634-$10,054; $p<0.001$) per person over two years, and has been presented in Table 3-6.

Table 3-5. Adjusted mean cost of ambulatory visits for community-dwelling US adults aged between 18-24 years (2011 US$)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,715 (355)	-
Chronic Back Pain[a]	$13,427 (4022)	11,712 (3,866-19,559; p=0.004)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-6. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 18-24 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,737 (367)	-
Alternate Chronic Back Pain group[a]	$8,580 (1,591)	$6,843.77 (3,634-10,054; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of ambulatory visits in persons aged 25-34 years old reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.85 – indicative of a gamma distribution. A generalized linear model with a gamma distribution and log link was used with the same covariates used in the previous model, namely, age, gender, race, US Census Region, insurance status, self-reported health status and disability measures, and number of comorbidities. Adjusted costs for the CBP and Control groups are presented in Table 3-7. The difference in mean cost for ambulatory visits between the CBP and Control groups was not statistically significant in this age group [Difference = US$4,312 (95% CI: $65-$8,559; p=0.047) over two years per person].

Thus, there is insufficient evidence to reject Hypothesis 3a-ii (H03Aii: $AMBV_{CBP25\text{-}34} = AMBV_{NoCBP25\text{-}34}$).

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed difference in mean cost was US$7,531 (95% CI: $1,107-$13,955; p=0.022) per person over two years, and has been presented in Table 3-8. This was not statistically different at the a priori level of $p < 0.01$.

Table 3-7. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 25-34 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,693 (160)	-
Chronic Back Pain[a]	$6,005 (2,145)	$4,312 (65-8,559; p=0.047)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-8. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 25-34 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,684 (158)	-
Alternate Chronic Back Pain group[a]	$9,215 (3,255)	$7,531 (1,107-13,955; p=0.022)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of ambulatory visits in persons aged 35-44 years old reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.87, and indicative of a gamma distribution. As in previous models, a generalized linear model with a gamma distribution and log link was used to adjust for covariates. Adjusted costs for the CBP and Control groups are presented in Table 3-9. When compared with persons not reporting back pain over the study period (Control group), persons with chronic back pain had a statistically significant mean excess ambulatory visits cost of US$11,553 (95% CI: $5,390-$17,716; $p<0.001$) over two years per person.

Thus, H03Aiii: $AMBV_{CBP35\text{-}44} = AMBV_{NoCBP35\text{-}44}$ (Hypothesis 3a-iii) was rejected.

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$16,770 (95% CI: $5,720-$27,820; $p=0.003$) per person over two years, and has been presented in Table 3-10.

Table 3-9. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 35-44 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,431 (146)	-
Chronic Back Pain[a]	$13,983 (3,125)	$11,553 (5,390-17,716; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-10. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 35-44 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,416 (142)	-
Alternate Chronic Back Pain group[a]	$19,186 (5,608)	$16,770 (5,720-27,820; p=0.003)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of ambulatory visits in persons aged 45-54 years old reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.83, and indicative of a gamma distribution. A generalized linear model with a gamma distribution and log link was used to adjust for covariates. Adjusted costs for the CBP and Control groups are presented in Table 3-11. Persons with chronic back pain had a statistically significantly higher mean cost for ambulatory visits compared with the Control group [Difference = US$14,450 (95% CI: $8,100-$20,800; $p<0.001$)over two years per person].

Thus, H03Aiv: $AMBV_{CBP45\text{-}54}= AMBV_{NoCBP45\text{-}54}$ (Hypothesis 3a-iv) was rejected.

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$10,134 (95% CI: $5,857-$14,413; $p<0.001$) per person over two years, and has been presented in Table 3-12.

Table 3-11. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 45-54 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$3,078 (100)	-
Chronic Back Pain[a]	$17,527 (3,228)	$14,450 (8,100-20,800; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-12. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 45-54 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$3,085 (100)	-
Alternate Chronic Back Pain group[a]	$13,220 (2,170)	$10,134 (5,857-14,413; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of ambulatory visits in persons aged 55-64 years old reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.71, and indicative of a gamma distribution. A generalized linear model with a gamma distribution and log link was used to adjust for covariates. Adjusted costs for the CBP and Control groups are presented in Table 3-13. When compared with persons not reporting back pain over the study period (Control group), persons with chronic back pain had higher mean costs for ambulatory visits [US$10,970 (95% CI: $4,818-$17,121; p=0.001) over two years per person].

Thus, H03Av: $AMBV_{CBP55\text{-}64} = AMBV_{NoCBP55\text{-}64}$ (Hypothesis 3a-v) was rejected.

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$13,736 (95% CI: $8,111-$19,362; p<0.001) per person over two years, and has been presented in Table 3-14.

Table 3-13. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 55-64 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,376 (198)	-
Chronic Back Pain[a]	$15,346 (3,098)	$10,970 (4,818-17,121; p=0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-14. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between 55-64 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,354(199)	-
Alternate Chronic Back Pain group[a]	$18,090 (2,832)	$13,736 (8,110-19,361; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of ambulatory visits in persons aged 65 years or older reporting back pain

The Modified Park's test coefficient for the distribution of ambulatory visits cost in this age group was 1.62, and indicative of a gamma distribution. A generalized linear model with a gamma distribution and log link was used to adjust for covariates. Adjusted costs for the CBP and Control groups are presented in Table 3-15. When compared with persons not reporting back pain over the study period (Control group), persons with chronic back pain had higher mean costs for ambulatory visits [US$4,600 (95% CI: $3,704-$5,497; p<0.001) over two years per person].

Thus, H03Avi: $AMBV_{CBP\geq 65} = AMBV_{NoCBP\geq 65}$ (Hypothesis 3a-vi) was rejected.

When ambulatory visits cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$3,880.76 (95% CI: $3,044.77-$4,716.74; p<0.001) per person over two years, and has been presented in Table 3-16.

Table 3-15. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged between ≥65 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,585 (100)	-
Chronic Back Pain[a]	$9,186 (470)	$4,600 (3,704-5,497; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-16. Adjusted mean cost of ambulatory visits (in 2011 US$) for community-dwelling US adults aged ≥65 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,592 (101)	-
Alternate Chronic Back Pain group[a]	$8,473 (438)	$3,881 (3,045-4,717; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons reporting back pain stratified by age group

Given the high number of persons reporting no inpatient admissions cost (~76-84%, depending on age group under consideration), a two-part model was developed for each age group, as noted in the Methods section. Overall mean excess costs for inpatient admissions were found to be $3,560 ($6,514 vs. $2,914; $p<0.001$) per person over 2 years.

Excess cost of inpatient admissions in persons aged 18-24 years old reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups are presented in Table 3-17. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was not statistically significantly different from persons included in the Control group [Difference = US$1,248 (95% CI: $-88, +$2,584; p=0.067)].

Thus, H03Bi: $IP_{CBP18\text{-}24} = IP_{NoCBP18\text{-}24}$ (Hypothesis 3b-i) was not rejected.

When inpatient admissions cost for the ACBP group were compared with the Control group (Table 3-18), the computed mean excess cost was US$1,177 (95% CI: $130-$2,223;p=0.028). This was not significant at the a priori level of $p < 0.01$.

Table 3-17. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged between 18-24 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,847 (80)	-
Chronic Back Pain[a]	$3,095 (668)	$1,248 (-88.05, +2,583.76; p=0.067)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-18. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged 18-24 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,845 (79)	-
Alternate Chronic Back Pain[a]	$3,022 (513)	$1,177 (130-2,222;p=0.028)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons aged 25-34 years old reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups are presented in Table 3-19. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was not statistically significantly different from persons included in the Control group [US$650 (95% CI: -$39, +$1,339; p=0.064)].

Thus, H03Bii: $IP_{CBP25\text{-}34} = IP_{NoCBP25\text{-}344}$ (Hypothesis 3b-ii) was not rejected.

However, excess mean inpatient admission costs for the ACBP group was statistically significant and computed to be US$1,379 (95% CI: $832-$1,926; p<0.001) (Table 3-20).

Table 3-19. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged between 25-34 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,920 (43)	-
Chronic Back Pain[a]	$2,570 (345)	$650 (-39,-1,339; p=0.064)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-20. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged 25-34 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,908 (42)	-
Alternate Chronic Back Pain[a]	$3,287 (275)	$1,379 (832-1,925; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons aged 35-44 years old reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups are presented in Table 3-21. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was statistically significantly higher than the Control group [Difference = US$1,705 (95% CI $845-$2,565; p<0.001)].

Thus, H03Biii: $IP_{CBP35\text{-}44} = IP_{NoCBP35\text{-}44}$ (Hypothesis 3b-iii) was rejected.

Mean inpatient admissions cost for the ACBP group compared with the Control group was statistically significantly higher [US$1,927 (95% CI: $1,312-$2,541; p<0.001)] (Table 3-22).

Table 3-21. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged between 35-44 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,595 (43)	-
Chronic Back Pain[a]	$3,300 (438)	$1,705 (845-2,565; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-22. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged 35-44 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,590 (42)	-
Alternate Chronic Back Pain[a]	$3,517 (311)	$1,927 (1,312-2,541; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons aged 45-54 years old reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups are presented in Table 3-23. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was statistically significantly higher than for persons included in the Control group [Difference = US$4,735 ($3,527-$5,944; p<0.001)].

Thus, H03Biv: $IP_{CBP45\text{-}54} = IP_{NoCBP45\text{-}54}$ (Hypothesis 3b-iv) was rejected.

When inpatient admissions cost for the ACBP group were compared with the Control group, the computed mean excess cost was US$3,040 ($2,278-$3,802; p<0.001) (Table 3-24).

Table 3-23. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged between 45-54 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,316 (68)	-
Chronic Back Pain[a]	$7,051 (618)	$4,736 (3,527-5,944; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-24. Adjusted mean cost of inpatient admissions (in 2011 US$) for community-dwelling US adults aged 45-54 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,321 (69)	-
Alternate Chronic Back Pain[a]	$5,360 (392)	$3,040 (2,278, 3,802; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons aged 55-64 years old reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups for 55-64 year old US adults are presented in Table 3-25. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was statistically significantly higher than for persons included in the Control group [Difference = US$4,988 ($2,790-$7,186; p<0.001)].

Thus, H03Bv: $IP_{CBP55\text{-}64} = IP_{NoCBP55\text{-}64}$ (Hypothesis 3b-v) was rejected.

When inpatient admissions cost for the ACBP group were compared with the Control group, the ACBP group had significantly higher mean costs [Difference = US$4,240 ($2,462-$6,018; p<0.001)] (Table 3-26).

Table 3-25. Adjusted mean cost of inpatient admissions for community-dwelling US adults aged between 55-64 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,120 (152)	-
Chronic Back Pain[a]	$9,108 (1,078)	$4,988 (2,790-7,186; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-26. Adjusted mean cost of inpatient admissions for community-dwelling US adults aged 55-64 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,116 (152)	-
Alternate Chronic Back Pain[a]	$8,357 (875)	$4,240 (2,462-6,018; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of inpatient admissions in persons aged 65 years or older reporting back pain

Adjusted inpatient admission costs for the CBP and Control groups are presented in Table 3-27. Mean cost of inpatient admissions (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$3,638 ($2,709-$4,567; p<0.001)].

Thus, H03Bvi: $IP_{CBP65} = IP_{NoCBP65}$ (Hypothesis 3b-vi) was rejected.

Additionally, inpatient admissions cost for the ACBP group were significantly greater than the Control group; the computed mean excess cost was US$3,723 ($2,884-$4,561; p<0.001) (Table 3-28).

Table 3-27. Adjusted mean cost of inpatient admissions for community-dwelling US adults aged ≥65 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$5,790 (125)	-
Chronic Back Pain[a]	$9,428 (478)	$3,638 (2,709-4,567; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-28. Adjusted mean cost of inpatient admissions for community-dwelling US adults aged ≥65 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$5,782 (125)	-
Alternate Chronic Back Pain[a]	$9,504 (423)	$3,723 (2,884-4,561; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons reporting back pain stratified by age group

Similar to costs for inpatient admissions, a two-part model was used to estimate predicted mean costs for emergency room visits. Excess mean cost of emergency room visits were estimated at \$300 (\$690 vs. \$390; $p<0.001$) per person over 2 years.

Excess cost of emergency room visits in persons aged 18-24 years old reporting back pain

Emergency room visit costs for the CBP and Control groups, adjusted for previously listed covariates, are presented in Table 3-29. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US\$455 (\$260-\$649; $p<0.001$)].

Thus, H03Ci: $ER_{CBP18\text{-}24} = ER_{NoCBP18\text{-}24}$ (Hypothesis 3c-i) was rejected.

Cost for emergency room visits for the ACBP group was also significantly greater than the Control group; the computed mean excess cost was US\$1,031 (\$744-\$1,318; $p<0.001$) (Table 3-30).

Table 3-29. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 18-24 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$431 (13)	-
Chronic Back Pain[a]	$886 (97)	$455 (261-649;p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-30. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 18-24 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$428 (12)	-
Alternate Chronic Back Pain group[a]	$1,459 (145)	$1,030 (744-1,318 p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons aged 25-34 years old reporting back pain

Emergency room visit costs for persons included in the CBP and Control groups aged 25-34 years, adjusted for previously listed covariates, are presented in Table 3-31. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$233 ($113-$353; p<0.001)].

Thus, H03Cii: $ER_{CBP25\text{-}34} = ER_{NoCBP25\text{-}34}$ (Hypothesis 3c-ii) was rejected.

Cost for emergency room visits for the ACBP group was also significantly greater than the Control group; the computed mean excess cost was US$197 ($81-$314; p=0.001) (Table 3-32)

Table 3-31. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 25-34 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$343 (8)	-
Chronic Back Pain[a]	\$576 (60)	\$233 (113-353; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-32. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 25-34 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$344 (8)	-
Alternate Chronic Back Pain group[a]	\$541 (59)	\$197 (81-314; p=0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons aged 35-44 years old reporting back pain

Emergency room visit costs for 35-44 year olds in the CBP and Control groups, adjusted for previously listed covariates, are presented in Table 3-33. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$334 ($215-$454; p<0.001)].

Thus, H03Ciii: $ER_{CBP35\text{-}44} = ER_{NoCBP35\text{-}44}$ (Hypothesis 3c-iii) was rejected.

Cost for emergency room visits for the ACBP group was also significantly greater than the Control group; the computed mean excess cost was US$383 ($284-$482; p<0.001) (Table 3-34).

Table 3-33. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 35-44 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$364 (7)	-
Chronic Back Pain[a]	\$699 (61)	\$334 (215-454; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-34. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 35-44 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$364 (7)	-
Alternate Chronic Back Pain group[a]	\$747 (51)	\$383 (284-482; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons aged 45-54 years old reporting back pain

Emergency room visit costs for 45-54 year olds in the CBP and Control groups, adjusted for previously listed covariates, are presented in Table 3-35. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$209 ($134-$283; p<0.001)].

Thus, H03Civ: $ER_{CBP45-54} = ER_{NoCBP45-54}$ (Hypothesis 3c-iv) was rejected.

Mean cost for emergency room visits for the ACBP group was also significantly greater than the Control group [Difference = US$291 ($224-$357; p<0.001)] (Table 3-36).

Table 3-35. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 45-54 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$391 (6)	-
Chronic Back Pain[a]	\$600 (38)	\$209 (134-283; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-36. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 45-54 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	\$391 (6)	-
Alternate Chronic Back Pain group[a]	\$682 (33)	\$291 (224-357; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons aged 55-64 years old reporting back pain

Emergency room visit costs for the CBP and Control groups, adjusted for previously listed covariates, are presented in Table 3-37. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$407 ($263-$551; p<0.001)].

Thus, H03Cv: $ER_{CBP55\text{-}64} = ER_{NoCBP55\text{-}64}$ (Hypothesis 3c-v) was rejected.

Cost for emergency room visits for the ACBP group was also significantly greater than the Control group; the computed mean excess cost was US$243 ($146-$339; p<0.001) (Table 3-38).

Table 3-37. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 55-64 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$420 (8)	-
Chronic Back Pain[a]	$827 (71)	$407 (263-551; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-38. Adjusted mean cost of emergency room visits for community-dwelling US adults aged 55-64 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$418 (8)	-
Alternate Chronic Back Pain group[a]	$661 (47)	$243 (146-339; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of emergency room visits in persons aged 65 years or older reporting back pain

Emergency room visit costs for the CBP and Control groups, adjusted for previously listed covariates, are presented in Table 3-39. Mean cost of emergency room visits (over two years per person) for persons with chronic back pain was statistically significantly higher than persons included in the Control group [Difference = US$383 ($325-$441; p<0.001)].

Thus, H03Cvi: $ER_{CBP65} = ER_{NoCBP65}$ (Hypothesis 3c-vi) was rejected.

Cost for emergency room visits for the ACBP group was also significantly greater than the Control group; the computed mean excess cost was US$302 ($253-$352; p<0.001) (Table 3-40).

Table 3-39. Adjusted mean cost of emergency room visits for community-dwelling US adults aged ≥65 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$397 (8)	-
Chronic Back Pain[a]	$781 (30)	$383 (325-441; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-40. Adjusted mean cost of emergency room visits for community-dwelling US adults aged ≥65 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$398 (8)	-
Alternate Chronic Back Pain group[a]	$700 (25)	$302 (253-352; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons reporting back pain stratified by age group

Predicted mean costs of prescription medications for each group were estimated using a generalized linear model with gamma distribution and log link, controlling for key covariates included in all models of this study. The Modified Park's test was used to validate the appropriateness of the gamma regression for prescription medication costs. The overall excess mean cost over 2 years for prescription medications was found to be $19,849 ($23,873 vs. $4,024; p<0.001) per person.

Excess cost of prescription medications in persons aged 18-24 years old reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.80 – indicative of a gamma distribution. Prescription medication costs for 18-24 year olds reporting back pain are reported in Table 3-41. As can be seen from the table, the difference in medication cost between the CBP group and the Control group was not statistically significant [US$-768 ($-3,689, $2,153; p=0.605)]

Thus, there was insufficient evidence to reject Hypothesis 3d-i (H03Di: $MEDS_{CBP18\text{-}24} = MEDS_{NoCBP18\text{-}24}$).

The difference in prescription medication costs between the ACBP and Control groups also failed to reach statistical significance [US$201 (-$3,101,+$3,503;p=0.905)] (Table 3-42).

Table 3-41. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 18-24 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,298 (1,454)	-
Chronic Back Pain[a]	$1,530 (610)	-$768 (-3,689, +2,153; p=0.605)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-42. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 18-24 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,372 (1,521)	-
Alternate Chronic Back Pain[a]	$2,573 (903)	$201 (-3,101, +3,503; p=0.905)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons aged 25-34 years old reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.80 – indicative of a gamma distribution. Prescription medication costs for 25-34 year olds reporting back pain are reported in Table 3-43. The difference in medication cost between the CBP group and the Control group was not statistically significant [US$16,723 ($-10,641, $44,086; p=0.230)].

Thus, there was insufficient evidence to reject Hypothesis 3d-ii (H03Dii: $MEDS_{CBP25\text{-}34} = MEDS_{NoCBP25\text{-}34}$).

The difference in prescription medication costs between the ACBP and Control groups also failed to reach statistical significance [US$8,780 ($-1,927, $+19,489; p=0.107)] (Table 3-44).

Table 3-43. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 25-34 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,750 (624)	-
Chronic Back Pain[a]	$18,473 (13,870)	$16,723 (-10,641, +44,086; p=0.230)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-44. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 25-34 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$1,800 (652)	-
Alternate Chronic Back Pain[a]	$10,582 (5,396)	$8,780 (-1,927, +19,489; p=0.107)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons aged 35-44 years old reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.82 – indicative of a gamma distribution. Prescription medication costs for 35-44 year olds reporting back pain are reported in Table 3-45. Persons in the CBP group had significantly higher mean prescription medication costs in the study period, when compared to the Control group [Difference = US$13,513 ($5,019-$22,006; p=0.002)].

Thus, Hypothesis 3d-iii (H03Diii: $MEDS_{CBP35\text{-}44} = MEDS_{NoCBP35\text{-}44}$) was rejected.

However, the difference in prescription medication costs between the ACBP and Control groups was not statistically significant at the $\alpha = 0.01$ level [Difference = US$18,085 ($4,266-$31,904; p=0.011)] (Table 3-46).

Table 3-45. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 35-44 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,476 (283)	-
Chronic Back Pain[a]	$15,988 (4,313)	$13,513 (5,019, 22,005; p=0.002)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-46. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 35-44 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$2,484 (285)	-
Alternate Chronic Back Pain[a]	$20,568 (7,008)	$18,085 (4,266, 31,904; p=0.011)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons aged 45-54 years old reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.76 – indicative of a gamma distribution. Prescription medication costs for 45-54 year olds reporting back pain are reported in Table 3-47. Persons in the CBP group had substantial and significantly higher mean prescription medication costs in the study period, when compared to the Control group [Difference = US$21,398 ($7,201-$35,595; p=0.003)]. 45 to 54 year-olds had the highest mean difference in prescription medication costs amongst all age groups.

Thus, Hypothesis 3d-iv (H04Div: $MEDS_{CBP45-54} = MEDS_{NoCBP45-54}$) was rejected.

Additionally, the difference in prescription medication costs between the ACBP and Control groups was also statistically significant at the $\alpha = 0.01$ level [US$16,488 ($6,088-$26,888; p=0.002)] (Table 3-48).

Table 3-47. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 45-54 years

Group	**2-Year Cost Mean (SE)**	**Difference vs. Control (95% CI; p-value)**
Control	$3093 (156)	-
Chronic Back Pain[a]	$24,490 (7,221)	$21,398 (7,201-35,595; p=0.003)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-48. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 45-54 years (using alternate definition of chronic back pain)

Group	**2-Year Cost Mean (SE)**	**Difference vs. Control (95% CI; p-value)**
Control	$3,116 (157)	-
Alternate Chronic Back Pain[a]	$19,604 (5,281)	$16,488 (6,088-26,888; p=0.002)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons aged 55-64 years old reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.60 – indicative of a gamma distribution. Prescription medication costs for 55-64 year olds reporting back pain are reported in Table 3-49. Compared to the Control group, persons in the CBP group had significantly higher mean prescription medications cost in the study period [Difference = US$9,051 ($3,989-$14,113; p=0.001)].

Thus, Hypothesis 3d-v (H03Dv: $MEDS_{CBP55\text{-}64} = MEDS_{NoCBP55\text{-}64}$) was rejected.

Persons included in the ACBP group had significantly higher mean prescription medications cost than persons in the Control group [Difference = US$9,589 ($5,093-$14,084; p<0.001)] (Table 3-50).

Table 3-49. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 55-64 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,212 (220)	-
Chronic Back Pain[a]	$13,262 (2,542)	$9,051 (3,989-14,113; p=0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-50. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 55-64 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$4,186 (217)	-
Alternate Chronic Back Pain[a]	$13,775 (2,254)	$9,589 (5,093-14,084; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of prescription medications in persons aged 65 years or older reporting back pain

The Modified Park's test coefficient for cost of prescription medications in this age group was 1.62 – indicative of a gamma distribution. Prescription medication costs for persons 65 years or older reporting back pain are reported in Table 3-51. Persons in the CBP group had substantial and significantly higher mean prescription medications cost in the study period, when compared to the Control group [Difference = US$3,862 ($2,966-$4,759; p<0.001)].

Thus, Hypothesis 3d-vi (H03Dvi: $MEDS_{CBP65} = MEDS_{NoCBP65}$) was rejected.

The difference in mean prescription medication costs between the ACBP and Control groups was also statistically significant at the $\alpha = 0.01$ level [US$2,292 ($1,554-$3,029; p<0.001)] (Table 3-52).

Table 3-51. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 65 years or older

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$5,066 (112)	-
Chronic Back Pain[a]	$8,929 (468)	$3,863 (2,966-4,759; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-52. Adjusted mean cost of prescription medications (in 2011 US$) for community-dwelling US adults aged 65 years or older (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$5,080 (113)	-
Alternate Chronic Back Pain[a]	$7,372 (386)	$2,292 (1,554-3,029; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

INDIRECT COSTS

As noted in the Methods section, a two-part regression model was developed to compute mean indirect costs due to lost productivity after controlling for demographic and clinical factors. Overall excess indirect costs for CBP patients were $1,668 ($2,329 vs. $661; $p<0.001$). The results for the models developed in the age groups of interest are presented below.

Excess cost of lost productivity in persons aged 18-24 years old reporting back pain

Mean indirect costs for the CBP and Control groups are presented in Table 3-53. Compared to the Control group, 18-24 year olds included in the CBP group had, on average, significantly higher indirect costs over two years [Excess cost = US$4,076 ($1,491-$6,661; $p=0.002$)].

Thus, Hypothesis 4-i (H04i: $WRK_{CBP18\text{-}24} = WRK_{NoCBP18\text{-}24}$) was rejected.

Additionally, the ACBP group in this age category also had significantly higher mean costs compared to the Control group [Difference = US$1,732 ($991-$2,473; $p<0.001$)] (Table 3-54).

Table 3-53. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 18-24 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$409 (29)	-
Chronic Back Pain[a]	$4,485 (1,315)	$4,076 (1,491-6,661; p=0.002)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-54. Adjusted mean indirect cost for community-dwelling US adults aged 18-24 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$414 (30)	-
Alternate Chronic Back Pain group[a]	$2,146 (376)	$1,732 (991-2,473; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of lost productivity in persons aged 25-34 years old reporting back pain

Mean indirect costs for 25-34 year old adults are presented in Table 3-55. Compared to the Control group, 25-34 year olds reporting back pain in 3 or more consecutive rounds (CBP) had significantly higher mean indirect costs [Excess cost = US$1,271 ($819-$1,723; p<0.001)] per person.

Thus, Hypothesis 4-ii (H04ii: $WRK_{CBP25\text{-}34} = WRK_{NoCBP25\text{-}34}$) was rejected.

Additionally, the ACBP group in this age category also had significantly higher mean indirect costs compared to the Control group [Difference = US$1,154 ($573-$1,735; p<0.001)] (Table 3-56).

Table 3-55. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 25-34 years

Group	2-Year Cost Mean (SE))	Difference vs. Control (95% CI; p-value)
Control	$770 (20)	-
Chronic Back Pain[a]	$2,041 (226)	$1,271 (819-1,723; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-56. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 25-34 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$771 (20)	-
Alternate Chronic Back Pain group[a]	$1,925 (294)	$1,154 (573-1,735; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of lost productivity in persons aged 35-44 years old reporting back pain

Mean indirect costs for 35-44 year old adults are presented in Table 3-57. Compared to the Control group, 35-44 year olds reporting back pain in 3 or more consecutive rounds (CBP) had significantly higher indirect costs [Excess cost = US$2,258 (1,433-3,083; $p<0.001$)] per person.

Thus, Hypothesis 4-iii (H04iii: $WRK_{CBP35\text{-}44} = WRK_{NoCBP35\text{-}44}$) was rejected.

Additionally, the ACBP group in this age category also had significantly higher mean indirect costs compared to the Control group [Difference = US$1,951 (1,298-2,603; $p< 0.001$)] (Table 3-58).

Table 3-57. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 35-44 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$874 (26)	-
Chronic Back Pain[a]	$3,132 (417)	$2,258 (1,433-3,083; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-58. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 35-44 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$874 (27)	-
Alternate Chronic Back Pain group[a]	$2,824 (330)	$1,951 (1,298-2,603; p< 0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of lost productivity in persons aged 45-54 years old reporting back pain

Mean indirect costs for 45-54 year old adults are presented in Table 3-59. Compared to the Control group, Adults in this age group included in the CBP group had significantly higher mean indirect costs compared to the Control group [Difference = US$2,934 ($1,708-$4,161; p<0.001)].

Thus, Hypothesis 4-iv (H04iv: $WRK_{CBP45\text{-}54} = WRK_{NoCBP45\text{-}54}$) was rejected.

Adults aged 45-54 years old and included in the ACBP group also reported significantly higher mean indirect costs compared to the Control group [Difference = US$2,151 ($1,385-$2,918; p<0.001)] (Table 3-60).

Table 3-59. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 45-54 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$897 (28)	-
Chronic Back Pain[a]	$3,832 (621)	$2,934 (1,708-4,161; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-60. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 45-54 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$892 (27)	-
Alternate Chronic Back Pain group[b]	$3,043 (388)	$2,151 (1,385-2,918; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of lost productivity in persons aged 55-64 years old reporting back pain

Mean indirect costs for 55-64 year old adults are presented in Table 3-61. Compared to the Control group, 55-64 year olds reporting chronic back pain (CBP) had significantly higher indirect costs [Excess cost = US$1,677 ($1,058-$2,297; $p<0.001$)] per person.

Thus, Hypothesis 4-v (H04v: $WRK_{CBP55\text{-}64} = WRK_{NoCBP55\text{-}64}$) was rejected.

Additionally, the ACBP group in this age category also had significantly higher mean indirect costs compared to the Control group [Difference = US$1,486 ($1,062-$1,909; $p<0.001$)] (Table 3-62).

Table 3-61. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 55-64 years

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$690 (21)	-
Chronic Back Pain[a]	$2,367 (310)	$1,677 (1,058-2,297; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-62. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 55-64 years (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$689 (20)	-
Alternate Chronic Back Pain group[a]	$2,174 (213)	$1,485 (1,062-1,909; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

Excess cost of lost productivity in persons aged 65 years or older reporting back pain

Mean indirect costs for community-dwelling US aged 65 years or older adults are presented in Table 3-63. Compared to the Control group, older adults in the CBP group had significantly higher indirect costs [Excess cost = US$79.93 ($55.14-$104.72; $p<0.001$)] per person.

Thus, Hypothesis 4-vi (H04vi: $WRK_{CBP65} = WRK_{NoCBP65}$) was rejected.

Additionally, older adults in the ACBP group also had significantly higher mean indirect costs compared to the Control group [Difference = US$78.89 ($48.86 - $108.92; $p<0.001$)] (Table 3-64).

Table 3-63. Adjusted mean indirect cost (in 2011 US$) for community-dwelling US adults aged 65 years or older

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$118 (3)	-
Chronic Back Pain[a]	$198 (13)	$80 (55, 105; p<0.001)

a: Persons reporting back pain in 3 or more consecutive rounds

Table 3-64. Adjusted mean indirect cost for community-dwelling US adults aged 65 years or older (using alternate definition of chronic back pain)

Group	2-Year Cost Mean (SE)	Difference vs. Control (95% CI; p-value)
Control	$119 (3)	-
Alternate Chronic Back Pain group[a]	$198 (15)	$79 (49, 109; p<0.001)

a: Persons reporting back pain in 2 or more consecutive rounds

TOTAL COSTS

Total societal costs, defined here as the sum of total direct medical costs and total indirect costs, are presented for the Chronic Back Pain (CBP) and Alternate Chronic Back Pain (ACBP) groups, in Table 3-65. The CBP group (persons reporting back pain in 3 or more consecutive rounds) had a total societal cost of US$187 billion (in 2011 US$) over two years, or $23,140 per person with CBP. Of this amount, US$176 billion was the total direct medical cost over two years, while the indirect (lost productivity) costs was US$11.7 billion. As part of the planned sensitivity analysis, the ACBP group (consisting of persons reporting back pain in 2 or more consecutive rounds) had a total societal cost of US$322 billion over 2 years, or $21,081 per person with ACBP. The direct cost for the ACBP group over two years was US$302 billion, and the indirect cost was US$20.3 billion.

Table 3-65. Total societal cost (unadjusted) for community-dwelling US adults reporting back pain

	2-Year Cost [in 2011 USD, billions]	95% C.I.	
		Lower	Upper
Chronic Back Pain group[a]	187	163	211
Alternate Chronic Back Pain group[b]	322	290	354

a: Persons reporting back pain in 3 or more consecutive rounds
b: Persons reporting back pain in 2 or more consecutive rounds

Table 3-66. Direct medical and indirect costs (in 2011 US$) over 2 years for community-dwelling US adults reporting back pain

	Chronic Back Pain group[a]	Alternate Chronic Back Pain group[b]
Total costs[c]		
Direct costs	$176 billion	$302 billion
Indirect cost	$11 billion	$20 billion
Mean costs[d]		
Direct costs	$48,586	$45,751
Indirect cost	$2,330	$1,908

a: Persons reporting back pain in 3 or more consecutive rounds
b: Persons reporting back pain in 2 or more consecutive rounds
c: Total costs are presented as unadjusted costs
d: All mean costs are adjusted for demographic and clinical factors

UTILIZATION OF PROVIDER-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE

Proportion of persons reporting back pain with at least 1 complementary and alternative medicine (CAM) provider visit

The proportion of back pain patients with at least 1 CAM provider visit over 2 years was assessed and results are presented in Table 3-67. Amongst persons included in the CBP and ACBP groups, approximately 37% visited a CAM provider at least once.

Table 3-67. Number and proportion of persons reporting back pain and at least 1 CAM provider visit

Group	Persons with at least 1 CAM provider visit [n (%)]
Chronic Back Pain group[a] (weighted N = 8,081,118)	2,946,633 (36.5%)
Alternate Chronic Back Pain group[b] (weighted N = 15,274,308)	5,589,281 (36.6%)

a: Persons reporting back pain in 3 or more consecutive rounds
b: Persons reporting back pain in 2 or more consecutive rounds

Difference in costs between users and non-users of provider-based CAM among patients reporting chronic back pain

Difference in direct medical costs between users and non-users of provider-based CAM

Direct medical costs for CBP patients who used CAM providers at least once in the study period and those who did not are presented in Table 3-68, stratified by age group. While the difference in direct medical costs was not significantly different in any age group except 45-54 year olds [$29,958 for CAM users vs.$ 69,171 for non-users of CAM (p=0.01)], there is a trend of lesser medical costs for those CBP patients with at least one CAM provider visit during the study period.

Thus, H07Aiv: $DIRCOST_{CAM45\text{-}54}$= $DIRCOST_{NoCAM45\text{-}54}$ (Hypothesis 7a-iv) was rejected. There is insufficient evidence to reject the other null hypotheses that were tested around direct medical costs for provider-based CAM users versus non-users (H_{07Ai} - $H_{07Aiii;}$ H_{07Av} - H_{07Avi}).

Table 3-68. Comparison of mean 2-year direct medical costs by age group between users and non-users of provider-based CAM within the Chronic Back Pain group

Age Group	≥1 CAM provider visit in study period	Direct Medical Cost [in 2011 USD] Mean (SE)	Difference vs. Reference (95% CI; p-value)
18 – 24	No (Reference)	$43,065 (22,390)	-
	Yes	$19,845 (4,849)	-$23,220 (-69,551, +23,110; p=0.317)
25 – 34	No (Reference)	$26,148 (8,894)	-
	Yes	$11,254 (1,457)	-$14,894 (-32,806, +3,018; p=0.102)
35 – 44	No (Reference)	$51,404 (12,446)	-
	Yes	$27,736 (11,153)	-$23,668 (-56,850, +9,514; p=0.161)
45 – 54	No (Reference)	$69,171 (14,322)	-
	Yes	$29,958 (4,969)	-$39,213 (-68,739, -9,687; p=0.01)
55 – 64	No (Reference)	$65,101 (16,292)	-
	Yes	$47,366 (15,345)	-$17,735 (-62,173, +26,703; p=0.431)
≥65	No (Reference)	$33,083 (1,993)	-
	Yes	$33,022 (2,952)	-$61 (-7,009, +6,886; p=0.986)

Difference in indirect costs between users and non-users of provider-based CAM

Similar to direct medical costs, while indirect (lost productivity) costs were not statistically significantly different between users and non-users of CAM providers in the CBP group, a trend towards lesser lost productivity can be noted in some groups (Table 3-69). Thus, we fail to reject hypotheses H_{07Bi} - H_{07Bvi}.

Table 3-69. Comparison of mean 2-year indirect costs by age group between users and non-users of provider-based CAM within the Chronic Back Pain group

Age Group	≥1 CAM provider visit in study period	Indirect Cost [in 2011 USD] Mean (SE)	Difference vs. Reference (95% CI; p-value)
18 – 24	No (Reference)	\$2,392 (954)	-
	Yes	\$2,822 (1,267)	\$430 (-2,776, +3,637; p=0.788)
25 – 34	No (Reference)	\$1,936 (304)	-
	Yes	\$1,288 (133)	-\$649 (-1,298, -3; p=0.05)
35 – 44	No (Reference)	\$2,926 (428)	-
	Yes	\$2,209 (528)	-\$717 (-2,066, +631; p=0.295)
45 – 54	No (Reference)	\$4,180 (781)	-
	Yes	\$2,349 (484)	-\$1,830 (-3,416, -244; p=0.024)
55 – 64	No (Reference)	\$2,290 (440)	-
	Yes	\$1,366 (287)	-\$924 (-1,975, +128; p=0.085)
≥65	No (Reference)	\$147 (11)	-
	Yes	\$163 (16)	\$16 (-20, +52; p=0.386)

RESULTS OF HYPOTHESIS TESTING

A summary of results of hypothesis testing is presented in Table 3-70.

Table 3-70. Results of hypothesis testing

Null hypothesis	Result[a]
Hypotheses for ambulatory visits by age groups	
In adults between 18 – 24 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with chronic back pain (CBP) and those without, keeping all other factors constant.	Rejected
In adults between 25 – 34 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.	Not rejected
In adults between 35 – 44 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 45 – 54 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 55 – 64 years, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults aged 65 years and above, there is no significant difference in the average cost of ambulatory visits (office-based and hospital outpatient department physician visits) between persons with CBP and those without, keeping all other factors constant.	Rejected
Hypotheses for hospital inpatient admissions by age groups	
In adults between 18 – 24 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Not rejected
In adults between 25 – 34 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Not rejected

Table 3-70 (Continued). Results of hypothesis testing

Null hypothesis	Result[a]
In adults between 35 – 44 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 45 – 54 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 55 – 64 years, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults aged 65 years and above, there is no significant difference in the average cost of hospital inpatient admissions between persons with CBP and those without, keeping all other factors constant.	Rejected
Hypotheses for emergency room visits by age groups	
In adults between 18 – 24 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 25 – 34 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 35 – 44 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 45 – 54 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 55 – 64 years, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults aged 65 years and above, there is no significant difference in the average cost of emergency room visits between persons with CBP and those without, keeping all other factors constant.	Rejected
Hypotheses for prescription medications by age groups	
In adults between 18 – 24 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Not rejected

Table 3-70 (Continued). Results of hypothesis testing

Null hypothesis	Result[a]
In adults between 25 – 34 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Not rejected
In adults between 35 – 44 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 45 – 54 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 55 – 64 years, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults aged 65 years and above, there is no significant difference in the average cost of prescription medications between persons with CBP and those without, keeping all other factors constant.	Rejected
Hypotheses for indirect cost by age groups	
In adults between 18 – 24 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 25 – 34 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 35 – 44 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 45 – 54 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults between 55 – 64 years, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected
In adults aged 65 years and above, there is no significant difference in average indirect cost between persons with CBP and those without, keeping all other factors constant.	Rejected

Table 3-70 (Continued). Results of hypothesis testing

Null hypothesis	Result[a]
Hypotheses for direct costs for CBP patients by CAM status and age groups	
In CBP patients between 18 – 24 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 25 – 34 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 35 – 44 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 45 – 54 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Rejected
In CBP patients between 55 – 64 years, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 65 years and above, there is no significant difference in average direct cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
Hypotheses for indirect cost for CBP patients by CAM status and age groups	
In CBP patients between 18 – 24 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 25 – 34 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 35 – 44 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected

Table 3-70 (Continued). Results of hypothesis testing

Null hypothesis	**Result**[a]
In CBP patients between 45 – 54 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 55 – 64 years, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected
In CBP patients between 65 years and above, there is no significant difference in average indirect cost between persons who use CAM providers at least once in the study period and those who do not, keeping all other factors constant.	Not rejected

a: Hypotheses were rejected at $p \leq 0.01$

Chapter 4: Discussion & Conclusion

The purpose of this section of the dissertation report is to provide a summary of findings and a comparison of findings with the existing literature on the societal burden of chronic back pain. The strengths and limitations of the current analysis will also be discussed in this section, along with recommendations for future research, potential implications, and final conclusions.

As discussed in the literature review, there is a need for a societal estimate of the burden of chronic back pain in the United States. Back pain is the 6th costliest medical condition in the United States [3] and approximately 80% of American adults are projected to suffer from back pain at least once in their lifetime.[56] A more recent study found back pain to have the highest cost amongst all pain conditions in the privately insured and Medicare populations.[57] The current study uses MEPS longitudinal files containing data from Panels 12, 13, and 14, spanning January 1, 2007 to December 31, 2010. Results from these analyses are generalizable to the community-dwelling US adult population.

A comparison of the demographic characteristics between the study population and 2010 US Census data (based on gender and race composition) is shown in Table 4-1. The demographic composition seen in the study was similar to the US population composition found in the 2010 Census.[58] This study found the overall community-dwelling US population 18 years and older to be 215,179,978. In comparison, the 2010 US Census data reported the US adult population (≥18 years) was 234,564,071. The difference in population estimates between the current study and the US Census data could be due to 3 reasons: a) MEPS included only community-dwelling adults in the US; b) while the Census data were collected in 2010, MEPS data used in this study were collected from January 2007 to December 2010; and c) the population for the current analysis was limited to persons reporting data in all five rounds of MEPS.

Table 4-1. Gender and race composition in the US population reported in the 2010 US Census report and 2007-2010 MEPS

Demographic characteristic	Proportion in MEPS[a]	Proportion in US Census 2010[b]
Gender		
Male	48.0%	49.2%
Female	52.0%	50.8%
Race		
White	82.0%	77.9%
Black	11.0%	13.1%
American Indian/Alaska Native	0.8%	1.2%
Asian	4.5%	5.1%
Native Hawaiian/Pacific Islander	0.3%	0.2%
Multiple races reported	1.4%	2.4%

a: Based on US population ≥18 years with data in all 5 MEPS rounds
b: Based on complete US population in 2010 (not age-restricted)

PREVALENCE AND COSTS OF CHRONIC BACK PAIN

The proportion of community-dwelling US adults reporting back pain in at least 3 consecutive rounds in this study was 3.8% (95%CI: 3.4-4.1). This prevalence estimate differs from previous studies, probably due to differences in the definition of chronicity. The current study's definition of chronicity of back pain (pain in 3 or more consecutive MEPS rounds, with each round being 3-6 months apart) might be considered conservative when compared with the definitions used by other researchers as well as by The National Health and Nutrition Examination Survey [NHANES] (chronic back pain = presence of back pain on most days for at least 3 months). This difference is demonstrated when comparing it to the prevalence estimate of chronic back pain reported in the 2009 to 2010 NHANES, which was 19.3% of 20-65 year-olds.[59]

Our estimates are consistent with those reported by Smith et al.[54] The current study found 1,024 (unweighted) persons reporting back pain in 3 consecutive MEPS rounds with data spanning Panels 12-14. Smith et al. used data from MEPS Panels 5-10, used the same definition of chronicity, and found the unweighted total number of persons reporting chronic back pain to be 2,555. The difference in estimates can be attributed to the fact that the current study assessed data from 3 panels compared with 5 panels assessed by Smith et al.

The current study found that approximately 38 million American adults suffer from back pain. Our estimate is similar to the a study conducted by Martin et al.[4] (approximately 33 million adults in the US reported back pain) using MEPS files from 2005, as well as the same ICD-9 diagnosis codes as the current study for patient identification. The difference in the results could be due to a difference in the time-frame of the two surveys, and can be attributed to the growth in prevalence of back pain as reported in the literature previously.[4,7,54] Smith and colleagues used longitudinal data from MEPS Panel 11 (years 2006 to 2007) and found a prevalence estimate similar to the current study (approximately 39 million American adults reported back pain in Panel 11).[4]

The proportion of persons reporting chronic back pain increases with increasing age with a peak in the 55-64 age group (1% in 18-24 year olds; 1.7% in 25-34 year olds; 3.8% in 35-44 year olds; 5% in 45-54 year olds; 5.4% in 55-64 year olds; and 5% in persons 65 years and older). Similar distribution by age group has been reported previously – back pain being more common in persons older than 45 years compared to younger adults, with a slight fall in adults over 65 years.[2,4]

The total societal cost for community-dwelling, civilian US adults with chronic back pain (CBP group) was US$187 billion (in 2011 US$) over two years, or $23,140 per person with CBP. Of this amount, US$176 billion was the total direct medical cost over two years, while the indirect (lost productivity) costs were US$11.7 billion.

Overall estimates of mean excess cost of CBP over 2 years per person (in 2011 US$) for direct medical cost categories were:

- Ambulatory visits costs – $11,711 ($14,929 vs. $3,219; p<0.001)
- Inpatient services costs – $3,560 ($6,514 vs. $2,914; p<0.001)
- Emergency room visits costs – $300 ($690 vs. $390; p<0.001)
- Prescription medication costs – $19,849 ($23,873 vs. $4,024; p<0.001)

For all categories, we found a decrease in costs in persons 65 years and older. One of the reasons for this decrease might be enrolment of this population into Medicare and the restrictions in health expenditure introduced due to this change. Further research is needed to assess the impact of Medicare enrollment on healthcare utilization in older patients.

Previous literature reports costs over one year. Thus, the 2-year cost estimates will be halved to compare our results with other studies. Martin and colleagues[4] used cross-sectional MEPS files from 1997 to 2005 to estimate annual direct costs of persons with back and neck problems using the same ICD-9 diagnosis codes for identification of back pain patients as those used in the current analysis. Cost estimates between the current study and Martin et al. were similar. Direct costs in the Martin study totaled $85.9 billion in 2005 compared to $88 billion in our study (yearly estimate for 2007-2010). The costs in specific categories were also similar. Martin et al. reported total cost for inpatient admissions, ambulatory visits, emergency room visits, and prescription medications to be $23.7 billion, $30.8 billion, $2.6 billion, and $19.8 billion, respectively, in 2005. Yearly estimates for the same categories in the current study were $25.6 billion, $25 billion, $2.75 billion, and $21.8 billion, respectively. The small difference in estimates is probably due to inflation between 2005 and 2007-2010.

Smith et al. evaluated the prevalence and ambulatory visits costs of back pain using MEPS longitudinal data files from MEPS Panels 5-11 (years 2000 to 2007).[7] Chronic back pain patients were found to have total ambulatory visits cost of approximately $36 billion (in 2010 US$). While the prevalence estimate for back pain in general is comparable with the current study, the cost estimate of chronic back pain patients from that study cannot be used for comparison. The ambulatory visits cost computed by Smith and colleagues included only those persons reporting back pain and not having an inpatient admission. We did not make such a distinction. Secondly, the criterion used for chronicity was different in the two studies. Smith et al. classified any person reporting back pain in 3 or more rounds as having chronic back pain while the current analysis required back pain to be reported in 3 *consecutive* rounds to meet the threshold for chronicity. High ambulatory visit costs in the current study and Smith et al.

could be due to increase in the use of spinal injections, diagnostic tests and newer imaging modalities.

National estimates for other direct medical cost categories have not been computed previously, thus, comparison of our estimates with other studies is not possible. As mentioned earlier, we found that the difference in per person costs between patient reporting CBP and the Control group was highest for prescription medication costs ($19,849 over 2 years). Martin et al.[4] noted that prescription medication expenses were the fastest-growing costs for spine-related problems between 1997 and 2005. They attributed this growth to increasing use of expensive analgesic alternatives like fentanyl and sustained-release oxycodone. The relatively low mean cost per person for inpatient admissions in the CBP group ($6,514 over two years) needs further investigation beyond the scope of this study. One of the main reasons for inpatient admission of back pain patients is spinal fusion surgery. Between 1998 and 2008, annual number of spinal fusion surgery-related discharges increased 2.4-fold.[60] During the same period, hospital charges per spinal fusion surgery-related admission increased from $24,676 to $81,960. While charges are an overestimate of costs, an analysis of the cost of fusion surgeries in CBP patients might help throw some light on inpatient admission costs reported in this study.

The current study estimated the mean indirect cost of patients reporting chronic back pain to be $2,330 over 2 years per person. However, we observed that age stratification provided a clearer view of the distribution and magnitude of lost productivity estimates over time. Mean lost productivity costs were highest in 18-24 year olds ($2,243 per person per year) and lowest in adults older than 65 years of age ($98 per person per year), in keeping with most of the older population being retired from work. Adjusted mean indirect costs were $1,021; $1,566; $1,916; $1,184 for 25-34; 35-44; 45-54; and 55-64 year olds, respectively. The indirect cost obtained in our study might be misestimated due to the large proportion of wages we had to impute. This is further discussed in the ‘Limitations’ section below. A review of the published, English language, biomedical literature did not identify any studies dealing with indirect costs of chronic back pain. A few studies reported indirect costs for acute and chronic low back pain specifically. Ivanova et al. conducted a study using data from 2004 to 2006 from an American private insurance claims database (n = 35,295) and studied health services costs, prescription medication costs, absenteeism costs, and employer payments for disability days in lower back pain patients. [18] Annual mean indirect costs were US$ 2,606 (SD = US$ 4,876) per employee with low back pain per year vs. US$ 750 (US$ 2,525) for controls (n = 91,194 in each group). All costs in the study were reported in 2006 US$. Mean indirect costs might be higher in this study due to the inclusion of employer payments for disability days.

UTILIZATION AND COST IMPACT OF PROVIDER-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE FOR CHRONIC BACK PAIN

Approximately 37% of persons in the chronic back pain (CBP) and alternate chronic back pain (ACBP) groups (weighted n = 2,946,633 and 5,589,281, respectively) visited a CAM provider at least once during the study period. Martin et al. used the 2002-2008 cross-sectional, public use files from MEPS to examine and compare total and spine-related expenses between CAM and non-CAM users among back pain patients.[61] The authors found approximately 41% of persons reporting back and neck problems utilized CAM services at least once. However, there was no distinction between acute, acute recurrent, or chronic pain. When we used the same duration criteria as Martin and colleagues (no differentiation between acute and chronic pain), we found the proportion of persons reporting back pain and utilizing CAM services to be approximately 31.2%.This difference of 10% (which translates to a substantial difference in absolute numbers) can probably be explained by the difference in the definition of the denominator (non-CAM users) on which proportions were calculated in both studies. The current study used the same definition of CAM users as Martin et al.; however, Martin defined the denominator as persons reporting back pain at least once and having at least 1 medical, non-CAM visit, while our study defined the denominator as persons reporting back pain at least once without any medical visit-based criterion.

The incremental cost approach, as noted earlier, includes differences in all-cause costs between 2 groups (CAM users and non-users in this case), regardless of whether they are specifically for the disorder under consideration (e.g., back pain) or not. The incremental cost approach is therefore thought to be a “more holistic approach” than the attributable cost approach, with differences in expenditures between the groups attributed to the differences in specific variable (e.g., CAM use) under consideration, after controlling for covariates.[62] Similar to the current study, all-cause direct costs reported by Martin and colleagues were not statistically significantly different between CAM users and non-users.[60] The absolute differences between the two groups were lower than the current study, possibly due to the difference in defining CAM non-users. Legoretta et al. conducted a retrospective claims analysis using a database of privately insured individuals, and compared outcomes and costs between enrollees with chiropractic insurance coverage and those without.[28] While the researchers found that individuals with chiropractic coverage did have statistically significantly lower annual total direct medical costs (US$1,463 vs. US$1,671 per member per year; $p < 0.001$), results from the study are not generalizable at the national level, and to publicly insured or uninsured persons.

On reviewing the published literature, we did not find any publication on differences in lost productivity in back pain patients using CAM compared to those not using CAM. The current study is the first study to examine this outcome. Further research is needed to validate and compare estimates obtained in this study.

STRENGTHS AND LIMITATIONS

This is the first study to assess societal costs of CBP in the United States using a single, nationally representative database. Use of the longitudinal data files from MEPS enabled assessment of chronicity of back pain, while the weight variables included in the dataset enabled computation of national estimates of cost. Estimates obtained in this study are designed to be generalizable and representative of the community-dwelling adult population of the US, due to the nature of the data used. Various demographic and clinical factors were used as covariates to assess excess mean costs, thus providing a better estimate of average costs. Costs in all categories were stratified by age group to account for the rise in the prevalence of back pain with increasing age (peak in 45-54 year olds), with a slight decrease in older adults. Other covariates were controlled for using regression models with appropriate distribution and link specifications. The appropriateness of the distribution in the generalized linear models was validated using the modified Park's test.

Data for each MEPS Panel (spanning January 1 of one year to December 31 of the next year) is collected over 5 interview rounds spanning two-and-a-half years. As mentioned earlier, the period for which data are collected during an interview round is known as the 'reference period'. Taking Panel 14 as an example, for Round 1, the reference period covers the time period from January 1, 2009 to the interview date. For Round 5, the reference period covers the time period from the interview date for Round 4 to December 31, 2010. For Rounds 2, 3, and 4, the reference period is the time between the interview date of the previous round and the date of current interview administration. Due to the collection strategy employed by MEPS, data are subject to recall bias, telescoping, and other issues known to be associated with self-reporting of health and disability data. While health problems in MEPS are self-reported, the diagnoses are cross-referenced with data from hospitals, physicians, home health care providers and pharmacies (Medical Provider component of MEPS data). Self-reported health data in MEPS that is cross-referenced is used to impute missing information in MEPS-HC or to correct it in case of uncertainty. While self-reported data used here (i.e., reporting of back pain) may be subject to recall bias, it can be argued that health care professionals, in daily practice, rely on patients to report pain rather than on diagnostic tests.[63] Treatment and healthcare utilization for pain is based on self-report, and thus MEPS and other self-report/patient interview datasets are good resources for analysis of costs and patterns of use of health care services.

Another limitation of MEPS data is that one respondent per household reports data for all household members. The data reported include type of insurance coverage, specific descriptions of medical condition, number of missed work days, detailed health expenditure data, and health care utilization among others. A single respondent giving information for all household members might introduce some inaccuracy in data reporting.

Use of ICD-9 diagnostic codes for patient selection might be a limitation of this study. Diagnostic codes are subject to miscoding and errors that might result in misestimating costs. ICD-9 codes also do not take into account severity and duration of the disease.

The human capital approach was used in the determination of indirect costs in this study. Hourly wages and employment status were used to value lost productivity. This might not be the best approach to estimate productivity losses.[64] It is assumed that missed work will not be completed at a later time; that the employee will not work from home/remotely; or that another employee will not complete the same tasks. Thus, the assumption is that lost time at work is the same as lost productivity. An issue that ties into "lost time at work is the same as lost productivity" is the issue of presenteeism costs. A patient with back pain might not miss work, but might not be able to work at full capacity while at work. There is some loss in productivity even though the individual did not miss any hours of work. Such productivity loss due to reduced efficiency at work were not accounted for in the current study due to lack of data to assess such an issue. Caregiver costs were also not assessed as part of this study. Caregiver costs are an important component of the societal burden of any medical condition. Future research should focus on evaluating presenteeism and caregiver costs due to chronic back pain. Unemployed individuals and housewives/househusbands were not included in the computation of lost productivity and indirect costs. This is another drawback of the human capital approach.

Wages were calculated and imputed for persons missing such data. The national mean wage of $21.74 per hour was used. This was the national mean hourly wage reported by the Bureau of Labor Statistics for 2011.[65] Imputation of wage data was needed due to the large proportion of missing wages in the data set. This is a limitation of the study and may underestimate the extent of lost productivity. We did try to counter this by using occupation categories to estimate hourly wages. However, even after imputation by occupation category, wage data for more than 50% of the population were missing, requiring us to use the national average instead. A dataset with more complete wage data is required to accurately estimate the indirect costs due to chronic back pain.

Any period between half a day and a full day is considered as a missed work day in MEPS. This means that even if a person took a half-day off due to illness or injury, it is reported as full missed work day. This is a limitation in computing indirect cost estimates. However, this limitation of MEPS is more concerning in a cost study using the 'attributable cost approach'. Since we used the incremental cost approach and used all-cause loss in productivity for comparison between back pain patients and the Control group, we did not test uncertainty around the number of whole missed work days in each round.

The direct medical expenses reported in this study represent cost from all sources for medical care including self/family, Medicare, Medicaid, private insurance, Veterans Affairs, Tricare, other federal sources, State and local (non-federal) government sources, and Workers' Compensation. This approach provides a more accurate estimate of direct costs than those obtained from insurance claims databases. However, it needs to be noted that medication costs in MEPS do not include expenditures for over-the-counter (OTC) medications. This might be especially problematic in a population of back pain patients. A substantial portion of these patients do not use health care services for their back pain,[7] which might result in them not acquiring prescriptions for medications.

Certain psychiatric and substance abuse comorbidities are known to be correlated with chronic back pain. Evaluating outcomes for CBP patients with specific comorbidities was beyond the scope of this study. Future research to focus on the economic outcomes in patients with chronic back pain as well as comorbidities is needed.

Lastly, the original objective of this study, i.e., estimation of costs for chronic lower back pain, could not be completed due to a paucity of data. Future research should focus on estimating costs for lower back pain patients in the US. However, finding a single, representative dataset might be an exercise in futility. A better approach might be to use various data sources to estimate costs for this population in specific subgroups and use available cost ratios to improve generalizability and to arrive at a societal estimate. Such an approach has been employed by Birnbaum et al. to estimate societal costs of opioid abuse in the US and might be useful here.[66]

CONCLUSION

This is the first study to report societal costs for chronic back pain patients living in the US. The results obtained are generalizable to the adult, community-dwelling US population. We found that direct medical costs account for the majority of total costs. We also confirmed the increasing prevalence of chronic back pain with increasing age, with the highest prevalence in persons between 45 and 64 years of age. The high cost of chronic back pain in the US population has potential implications for policy-makers in prioritizing policy, and health care providers in attempting to improve care and outcomes for these patients. These analyses help indicate groups (based on age, race, US Census region) with high costs and potential targets for interventions in terms of duration and severity of back pain. Further analyses of predictive factors for these high costs are needed in order to fine-tune policy. Physicians can investigate the reasons for the increasing cost of prescription medications in back pain patients, which may help to identify patients being overmedicated or abusing controlled substances. Further research is needed to clarify the definition of chronicity in back pain patients, societal costs of low back pain in the US population, as well as on estimation of costs of chronic back pain patients who have no contact with the health care system (patients who self-treat with OTC medications, heating pads, etc.), and whose data are not captured in retrospective databases.

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